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ABSTRACT

This report describes the planning, implementation, and outcomes of the first phase of a project to create and implement computer-based materials for a problem-oriented curriculum in a training program for physician assistants. It examines the underlying causes of the project's failure to achieve the Phase I objectives, and documents them as lessons learned and situations to avoid in future projects. The information on which the present report is based was gathered informally; correspondence, documents produced by the Sheppard staff, notes made by consultants during site visits, and interviews with staff members are the major sources of data. Following the introduction, a brief history of major events is given. The subsequent section identifies the four most significant outcomes or problem areas, and analyzes their causes. The final section gives a summary of the major outcomes, briefly states some additional outcomes, and gives an overall assessment of the Phase I effort. Appendices include the request for training research, the Problem-Oriented Medical Curriculum (POMC) implementation plan, the POMC evaluation plan, and the proposal for Phase II. (VT)

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ANALYSIS OF SHEPPARD AFB COMPUTER-BASED EDUCATION PROJECT

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CRITICAL ANALYSIS OF THE INITIAL PHASE OF THE SHEPPARD AFB CBE PROJECT: THE PROBLEM ORIENTED MEDICAL CURRICULUM

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INTRODUCTION

Background

In November, 1973, a research agreement with the title "Evaluation of PLATO IV System in Air Force Medical Training" was signed between representatives of the USAF School of Health Care Sciences (SHCS) at Sheppard AFB, the Air Force Human Resources Laboratory (AFHRL), and the Defense Advanced Research Projects Agency (ARPA) of the Department of Defense. The agreement called for the research and development of a new problem-oriented medical curriculum (POMC) for the Physician Assistant program offered at Sheppard's SHCS. The new curriculum was to be developed and implemented on the PLATO IV computer-based education system. A major objective of the project was to be a comparative evaluation of the instructional effectiveness of the new problem-oriented materials and the existing traditional curriculum.

Under the terms of the agreement, the Air Force's Air Training Command (ATC) was to furnish (through SHCS) a staff of subject matter specialists and support personnel to develop the new curriculum, sufficient classroom and laboratory space to house the project, and enough physician assistant students to form the evaluation sample.

AFHRL was to develop an evaluation plan in conjunction with SHCS and to provide direction for and monitoring of the evaluation itself. In addition, AFHRL was to derive and implement measures of student and instructor attitudes as well as tests of student performance.

It was to be ARPA's responsibility to provide 20 PLATO IV terminals plus support costs for computer usage, communications lines, and terminal maintenance for three years of service at the Sheppard site. As well as providing hardware support, ARPA was to fund the Military Training Centers group (MTC) of the University of Illinois' Computer-based Education Research Laboratory (CERL) to provide SHCS staff with train-

ing and advice in the use of the PLATO system. The MTC group was also to cooperate in the development of curriculum materials for the project and perform other assistance as agreed to by the Sheppard project manager.

In mid-1975, at the time the Sheppard project had reached its implementation stage, the project sponsor (ARPA) asked CERL to prepare a proposal to do an evaluation of the Sheppard effort as well as those of other ARPA-supported PLATO projects. The MTC group had taken an important role in support of each of the major ARPA sites. This role included giving initial training in the TUTOR language, acting as liaison with the rest of CERL, making site visits for in-service training and problem solving, reviewing lessons to improve their pedagogical approach, etc. Since they had observed these projects from their inception, the MTC group was thcught by ARPA to be in a good position to assist in formative evaluation for the purpose of maximizing the effectiveness of each site. CERL's PLATO Educational Evaluation and Research group (PEER) was also enlisted to participate in the evaluation.

Another goal of the MTC/PEER evaluation which resulted from the contract with ARPA was to identify generalizable aspects of the experience of the ARPA-supported sites. The evaluation sought to address the overall question of "under what conditions can CBE make a cost effective contribution to the instructional needs of the services". PLATO implementations at Chanute AFB and Aberdeen Proving Ground sites were studied along with that at the Sheppard AFB site. Reports by Himwich (1977b), Call-Himwich (1977b), and Avner & Misselt (1977) focus on the experience at Aberdeen Proving Ground. The Chanute project is discussed in reports by Klecka (1977a; 1977b; 1978), Himwich (1977a), Misselt, Himwich, Francis, Avner, Tatsuoka & Klecka (1977), Tatsuoka, Misselt & Maritz (1978), and Tatsuoka (1978). The report by Call-Himwich (1978) on the POMC courseware is a companion to this account

of the Sheppard project. Other reports dealing with more general topics include a study of critical decisions made during various PLATO development projects (Steinberg et al., 1977) and a set of guidelines for site implementation and management (Francis, 1977).

Scope and Rationale

The Sheppard AFB CBE project had two distinct phases, each characterized by its own goals, timelines, and organizational structures. The first phase sought to create and implement CBE materials for a problem-oriented curriculum in the SHCS training program for physician assistants. It lasted from November, 1973, when the original research agreement was approved, until December, 1975, when the staff terminated the effort due to attrition in the student sample and other problems which threatened the integrity of the evaluation. After abandoning the first set of goals, the staff proposed a follow-on investigation which was to involve preparation and testing of CBE materials for the Medical Lab, Radiology, and Dental Assistant courses in the SHCS. This second proposal was approved in time to begin development of materials in March, 1976. Final data collection for the second phase ended on June 30, 1977.

This report deals exclusively with the plans, transactions, and outcomes of the first phase of the SHCS project. By virtue of the fact that the original goals of the project were abandoned (signifying the end of a first phase and the necessity of a second), the project failed to achieve its Phase I objectives. The main purpose of this report is to examine the underlying causes of that failure and to document them as lessons learned and situations to avoid in future projects. It would, of course, be desirable also to examine the major events and findings of the second phase. Unfortunately, the late completion date and CERL's reduced level of

contact with Sheppard during 1976-1977 make it impossible to extend the scope of our evaluation beyond Phase I. A full report of the Phase II effort is to be made by AFHRL after data analysis and interpretation are completed.

The information on which the present report is based was gathered informally throughout CERL's association with the Sheppard project. Correspondence, documents produced by the Sheppard staff, notes made by MTC consultants during site visits, and interviews with staff members are the major sources of data we have had available. The report by project staff and AFHRL researchers (Steinkerchner, Deignan, Waters & DeLeo, 1977) has also provided useful insight, and we are grateful to AFHRL for giving us access to a prepublication copy. Although we have utilized numerous sources of information to prepare this document, we recognize that other forms of data (e.g., interviews with course instructors, and closer observation of implementation conditions) would have significantly enhanced our understanding of Phase I.

Much can be learned from Sheppard's Phase I effort in spite of its failure to fully implement and evaluate the problem-oriented approach to medical education. In order to focus on the major outcomes of Phase I, some topics (e.g., the management of the courseware development and implementation activities and the ways in which CERL contributed to them) are discussed only briefly. However, much of this information is reported elsewhere (see Steinberg et al., 1977; Francis, 1977; and Steinkerchner et al., 1977).

The report is organized in four major sections. Following the introduction, a brief history of major events is given. The subsequent section identifies the four most significant outcomes or problem areas and analyzes their causes. The final section gives a summary of the major outcomes, briefly states some additional outcomes, and gives an overall assessment of the Phase I effort.

HISTORICAL SUMMARY

Project Origins

The Request for Training Research (RTR) dated 4 April 1973 is the earliest official document generated during the Sheppard project (see Appendix A). Prepared by an official in the School of Health Care Sciences (hereafter known as the "project initiator"), the RTR outlined a rationale for the research effort and set out general plans for what was to be attempted.

In essence, the RTR described a shortage of physicians' services in the U. S. Air Force which could potentially be alleviated through the training of large numbers of physician assistants (PAs). A training program for PAs had been established at the SHCS in about 1970 with a comprehensive Plan of Instruction being completed in August, 1972. In the view of the project initiator, the existing PA curriculum suffered from the lack of a basic frame of reference for the core of medical knowledge to be memorized. He proposed a curricular reorganization intended to illustrate the clinical relevance of this material. Although it is not stated explicitly, the reader of the RTR may infer that a main benefit expected from increased clinical relevance was a decrease in training time. Part of the impetus for a reworking of the PA curriculum was the frequency of student questions about why a PA would need to know certain basic science material. Hence, making the curriculum more clinically relevant was expected to improve student attitudes. Another supposed benefit was that other allied health personnel would gain a better understanding of their own place along the "diagnosis-treatment" loop.

Hopes for redeveloping the PA course as a problem-oriented medical curriculum actually preceded the plans to use the PLATO system in this effort. It is our understanding that officials in the SHCS learned in early 1973 that a set

of 20 PLATO IV terminals originally intended by ARPA for one of the other services might be available for Air Force use. The project initiator saw this as an opportunity to fund the initial work on the POMC: he apparently was more interested in developing the new curriculum than in doing research with computer based education per se. The initial plans did, however, leave open the possibility that "non-POMC" CBE research might be attempted, as is indicated by the following statement from the RTR:

> During the development of this project, students will be exposed to both curricular formats (POMC and traditional) in which PLATO IV may or may not be employed. The suitability and contribution of computer-assisted instruction will be evaluated as it stands alone and vis-à-vis the curricula.

During the remainder of the spring and summer of 1973 there were a number of meetings between representatives of the SHCS staff and those of other agencies concerned with the project (CERL, ATC, and AFHRL) in order further to refine the plans. Because of the relative newness of the PLATO IV system and general lack of experience with large CBE curriculum development projects, ARPA agreed to fund CERL to provide support personnel for the Sheppard effort. Another event during this period was the attempt by the project initiator and other MDs on the PA course staff to draw up a plan to organize the PA curriculum around 24 sets of symptoms or "problems". Apparently it was still hoped that a full reorganization of the curriculum could be done, with CBE to be applied only to a part of it.

Project Organization

By November, 1973, a formal research agreement had been signed and the project was officially underway. It was also about this time that the project initiator finalized his plans

to leave the Air Force and an experienced administrator was selected to become acting director. In December, 1973, the acting director, the project initiator, and two other SHCS officials participated in planning discussions with members of CERL's MTC support group.

During the remainder of 1973 and the first few weeks of 1974, a number of organizational and staffing decisions were made. The acting director, having taken up residency at Sheppard AFB during this period, arranged for office space to house the project and its PLATO IV terminals. He also selected a number of staff members, some of whom were to join the project in February with others not coming until June or July, 1974.

A series of planning meetings was held at the SHCS in late February. Representatives of the MTC group met together with personnel from Sheppard's PLATO IV staff and instructors from the Physician Assistant's course. Among the major outcomes of these meetings were: (a) a working definition of a problem-oriented medical curriculum, (b) an understanding that the PLATO project would constitute the core of the research on the PA course (and that it was beyond the scope of the project to undertake the revision of the PA curriculum as a whole), (c) an indication from the project staff that the evaluation of PLATO IV as an instructional medium would be secondary to the evaluation of the POMC, (d) disclosure of plans to divide the development effort into a basic science component and a problem-oriented component, (e) a description of the intent to use PLATO in a wide variety of specific problem areas within the course, and (f) discussion of the role that might be taken by CERL's MTC group.

While awaiting the arrival of the primary subject matter specialist (a newly-graduated physician), the staff members already "on board" traveled to CERL to receive training in the TUTOR language, instructional design, and other aspects

of the use of PLATO IV (see Francis, 1976). Upon return to Sheppard AFB, they continued to develop their skills in lesson writing while refining the plans for the new curriculum. Work on a number of basic science lessons was begun while awaiting the physician, the "clinical" subject matter expert.

The weeks following the arrival of the physician were marked by a significant alteration of the project's direction. Whereas it had previously been planned to develop CBE materials for each of a number of topics which were thought to be well-suited for CBE application, it was decided during this period that all of the material related to a single organ system (the respiratory system) should be targeted for the POMC. The portions of the course Plan of Instruction (POI) dealing with respiration were identified and these topics were reorganized and reordered for incorporation into the POMC. Concurrent with the choice of respiration as subject matter was a reconsideration/redefinition of the POMC's nature. The subject matter specialist was given primary responsibility for planning the curriculum, and he reinterpreted the definition in a manner with which he could feel comfortable. A fuller discussion of this point is given later in the report.

Initial development work on elements of both the basic science component and a clinically-oriented portion of the POMC proceeded through the summer and fall of 1974. Among the major events of this period were: (a) the arrival of the remaining staff members allocated to the project (the last of whom was not assigned until November--one year after the project got underway), and (b) the initial planning for the implementation and evaluation phase.

Planning for the Implementation

Since plans for redeveloping the entire PA curriculum to be problem-oriented had been abandoned or postponed, the implementation of the POMC had to be done in such a way as

to minimize disruption of the regular course. An implementation plan was drawn up (see Appendix B) which called for the replacement of discrete hours of the regular curriculum with new CBE materials. In order to provide for a comparative evaluation, the project staff planned to select a sample of 16 students for the experimental (POMC) group with the remaining 48 students assigned to the regular curriculum. Only 16 subjects were to be assigned to the experimental condition because there were only to be 16 PLATO IV terminals for student use, and it was believed to be necessary to have a student to terminal ratio of 1 to 1. To increase the size of the n, however, the implementation plan provided for a replication of the comparison with the use of a second class of PA students. Hence, a total of 32 students were to be exposed to the POMC during the evaluation phase. An important consequence of the decision to use a second class of PA trainees was that the start of the implementation had to be moved forward from January, 1976, to October, 1975, and finally to July, 1975. Hence, the time available for lesson development was shortened by six months.

An evaluation plan was prepared in March, 1975, to outline specifications for data collection and analysis during the comparison (see Appendix C). It called for the use of a comprehensive examination over the respiratory topics covered in both curricula. The two groups were also to be compared on their performance in a set of simulated patient encounters. These latter exercises were expected to measure the problem-solving abilities of the PA trainees in the task of diagnosis and treatment of respiratory diseases and other patient ailments. The measurement of student attitudes toward the POMC and toward computer-based education was also an important component of the evaluation. The plan called for two administrations of an attitude questionnaire--one after a brief exposure to the POMC and the other after completion of the

first year of the PA program. The reliability and incorporability of the PLATO system were also to be investigated.

Results of the Implementation

In spite of the fact that some of the CBE lessons slated for first trimester use were not yet ready, the implementation got underway in July, 1975, as scheduled. The first class's initial use of the CBE lessons did not go smoothly. Students encountered a number of coding errors in the lessons, and there was an unfortunate mixup among the project staff as to the policies on student dress and behavior in the PLATO laboratory. The students were first told by some staff members that an informal atmosphere would be maintained. This "policy" was quickly rescinded by the project director, who felt that frequent visits from Air Force "brass" would require conventional dress and attendance patterns.

Scheduling of PLATO IV study sessions was a difficult problem. The 16 students in the experimental group were excused from the regular class sessions in which respiratory topics were to be discussed in order that they might receive alternative instruction on the PLATO IV system. Since it was necessary for them to rejoin the regular class at the next (nonrespiratory) sessions, they sometimes were not able to complete the assigned CBE lessons in the available time. To make up for such lost study time and to have opportunity for review of CBE materials, the POMC students often had to return to the PLATO IV classroom during evening hours.

The late summer months of 1975 were very busy ones for the project personnel. The severe time pressure on the staff to commence student use in July (which had left too little time for "debugging" of programs and coordination of policies regarding student dress and behavior) continued through the summer and fall. Not only did the staff have to rush to complete the first trimester lessons for the initial group

of students, they also had to prepare for the start of the second trimester. A number of second trimester lessons remained to be completed, and the first trimester lessons required revisions prior to being used with the next entering class. It was only through considerable effort and much overtime work that the project staff was able to meet its schedule. Nevertheless, the second trimester got underway with a second group of 16 students being assigned to the POMC condition. By this time there had been some attrition in the first class's experimental group so that only eight students continued to the second trimester's material.

Of the eight students from the first class who had left the POMC group by the start of the second trimester, five had been academically eliminated from the PA program. Three others had remained in the program but had requested to be dropped from the experiment in order to return to the regular classroom. Before the second trimester was completed, six of the remaining eight students also asked to go back to the classroom. As with the first class, the second set of PA students reacted negatively to the experimental conditions. Realizing that "nothing further could be done to resolve the misconceptions, relieve the anxieties, or change the negative attitudes of the students", the staff decided it would be a waste of time and money to continue the project with so few students and voted to terminate the POMC effort in December, 1975 (Steinkerchner et al., 1977).

At the time of the decision to discontinue the POMC, most of the CBE lessons planned for the first and second trimesters had been completed. Many of the third trimester materials, however, had not. Some of these latter lessons were to take the form of simulated patient encounters. Since the basic format of the simulations had been determined earlier, all that remained was to input the "data" from a set of actual clinical cases. The remaining third trimester

lessons, on the other hand, would have required more effort to develop. It is possible, but not likely, that they would have been completed in time for use had the POMC students not opted to leave the experiment.

Because of the early termination, much of the evaluation data called for by the evaluation plan (Appendix C) were not collected. There was no direct comparison of the POMC and regular curricula with regard to instructional effectiveness. Neither the knowledge of basic science material nor clinical problem-solving skills were compared between the two groups. The attitudinal data were collected, but the second administration of the questionnaire came at the time of the discontinuance of the POMC rather than at the end of the third trimester as had originally been planned. Unfortunately, the basic questions regarding the value of a problem-oriented curriculum in physician assistant training were not answered by the data collected during the Sheppard project.

Regrouping for Phase II

At about the time that the Sheppard staff decided to close out experimentation with the POMC, ARPA and CERL came to an agreement that the MTC group's support role would be curtailed. Although the MTC group had little opportunity under its changed role to keep abreast of the planning and implementation of Sheppard's second phase effort, it is important to indicate something of the nature of the second phase.

Planning for the follow-on project (or second phase) began in December, 1975. Looking for courses in which there was a high student flow and in which a high level of faculty involvement was likely, the Sheppard staff selected the Medical Lab, Radiology, and Dental Assistant courses within the SHCS. Other planning considerations were: (a) the requirement that identical criterion measures be administered to CBE and control groups at the lesson test and block test levels, (b) thorough measurement of learners' entering characteristics,

and (c) the capability of running separate CBE and control groups for an entire block of instruction (Steinkerchner et al., 1977). The criterion of high instructor involvement demonstrates that the staff wanted to identify courses whose instructors felt they had problems that could be solved by use of PLATO. The PLATO staff had learned the importance of high instructor involvement from their experience in the POMC phase of the project.

Development work on the new materials began in March, 1976, with preliminary data collection scheduled to take place later that summer. Because the original contract with ARPA was to expire September 30, 1976, an extension was funded until June 30, 1977. Formal data collection for a summative evaluation was to commence in November, 1976, and continue until the end of the ARPA-funded extension. A final report was scheduled for completion by December, 1977.

According to the research agreement for the extension period (see Appendix D), the main goals of the follow-on effort and its evaluation were: (a) comparison of instructional effectiveness of CBE lessons and lessons presented by lecture or by conventional self-paced media, (b) determination of costs of CBE and non-CBE instruction in the three courses, (c) determination of factors underlying student attitudes toward CBE, and (d) determination of factors underlying attitudes of instructors toward CBE.

ANALYSIS OF PROJECT OUTCOMES

Student Withdrawal from Experiment

The major reason for the staff's decision to abandon the POMC effort was the heavy loss of subjects from the experimental group due to academic failure and dissatisfaction with the experimental conditions. As stated above, five of the original 16 POMC students (31%) were eliminated from the PA program due to poor academic performance. Only six of the 48 control-group students (12.5%) were dropped during the same period. In spite of its higher dropout rate, the POMC group's five eliminees did not feel that their failure was related to participation in the experiment. Instead, they attributed their problems to rapid pacing in the regular portion of the course (Steinkerchner et al., 1977). Nevertheless, the losses due to academic attrition dealt a severe blow to the project's chances for a successful outcome.

Although the academic eliminations may not have been related to the POMC or its implementation, eight of the remaining eleven students in the first class asked to leave the POMC group because they were unhappy with the experimental conditions. This mass dissatisfaction was expressed informally at first through individual complaints to the Sheppard PLATO staff. Ultimately, however, the dissident group submitted formal letters of request that they be transferred back to the regular classroom. This latter action prompted the project staff to terminate the POMC effort.

The underlying causes of student dissatisfaction--perhaps the most striking outcome of the POMC effort--are numerous, but they are rooted in the severe implementation constraints imposed on the project. A discussion of these constraints must begin with an understanding of the students' perspective.

As Physician Assistant trainees, the students were a highly-motivated and strongly goal-oriented group. They had

all worked in health care specialties during their Air Force or Navy careers and many were hopeful of working as PAs after leaving the service. Career aspirations and family pressures made success in the PA curriculum a very important objective.

Because nearly all of the academic training was covered in the first year of the two year program, the general pace of the course was rapid and tightly scheduled. Students spent six to eight hours in classwork each day and were expected to complete reading assignments and outside study during the evening hours and on weekends. Most participated in small study groups to review lecture notes and prepare for the frequent examinations in the various subject areas. Hence, there was ample opportunity for them to exchange views on instructors, events of the day, and their progress through the curriculum, as well as to discuss specific items of course content.

The POMC implementation plan (see Appendix B) called for the replacement of discrete hours of classroom lecture with newly-developed CBE lessons. The 16 students selected for the POMC group (one fourth of the class of 64) were to leave the classroom during the times the target respiratory materials were to be presented in order to study newly-created lessons from the POMC. Since the POMC involved a reorganization of the respiratory content of the curriculum, the topic studied by the experimental group on a particular day was often quite different from that covered in the regular classroom.

The PLATO staff tried to assure the experimental group students that although the POMC would present topics in a different order, eventually all would be covered. Nevertheless, the students were frequently disconcerted to find that the classroom instructor had presented "new" material that they had "missed" while attending a PLATO session. Because of their compulsion to do well in the course, these students often felt that they had to work harder to "keep up" with the

class. This presumably meant that they spent time studying the lecture notes of friends or in doing "extra" reading assignments. The concern about missing lectures was so great that some students considered the POMC to be an additional course rather than an alternative presentation of some of the same material.

We have not had access to the letters of "mutiny", but it is apparent from the interview and questionnaire data summarized by Steinkerchner et al. (1977) and the informal reports of project members that the major complaint of the students was that they felt they were not getting the same information as that presented to the rest of the class. The second most frequent complaint was directed at the test grading procedures used to accommodate the experimental conditions. According to the plan, the regular instructors were to meet with a PLATO staff representative to discuss each test prior to its administration. If the test contained items that had not yet been taught in the POMC, the instructor was to identify them as items to be omitted by the POMC students. The PLATO staff, on the other hand, was to be responsible for testing the POMC students over those items at a later date. The test scores for the POMC group were to be recorded as the percentage of "non-omitted" items that were answered correctly. Scores were later adjusted to reflect performance on the make-up tests given by the PLATO staff. The procedure was complicated at best and it was not implemented smoothly--at least one instructor in the course was never told how it was to work. Students distrusted the process and, because of their great concern with course grades, they were often upset at not being given credit for correct responses to "omitted" items.

Another student complaint was that they often lacked a sense of where they were going in the POMC, i.e., they did not have a concept of the overall organization of the new

curriculum. The uncertain rate of development of future lessons made it difficult to publish a comprehensive schedule or syllabus for student use. Furthermore, the scattered distribution of respiratory topics in the regular Plan of Instruction, and hence the sporadic scheduling of PLATO sessions, made the POMC appear especially disjointed and fragmented. Because of the lengthy intervals between PLATO sessions, students following a tightly-knit argument or presentation in the POMC sequence often found it necessary to review previous lessons before continuing through the curriculum.

As mentioned earlier, the POMC students ultimately stated that contact with the PLATO staff was among the most positive aspects of their experience, but they may not have been favorably impressed at the outset. They were told in their initial orientation to the project that they would have certain freedoms in dress, attendance patterns, and behavior while in the PLATO classroom. These raised expectations were soon lowered again when the project director returned from an out-of-town assignment. Realizing that the project would have high visibility (particularly among high ranking visitors to the SHCS), he rescinded the promised freedoms and insisted instead on a high standard of military decorum. The impact of this mixup in communication among the staff (i.e., failing to settle on a consistent policy for student dress and attendance prior to the initial orientation) is difficult to gauge. Doubtless, however, it did not leave a favorable impression.

Another problem that dampened students' initial enthusiasm for the CBE project was that the lessons had not been completely "debugged". There were still a number of coding errors which detracted from the instructional presentation. These errors and the policy mixup described above were probably all due to the great time pressure placed on the project

staff by the implementation schedule they adopted. There was too little opportunity to do adequate testing of the lessons and to plan for a smooth implementation.

There were also a number of complaints about lesson quality. In reviewing the discussion by Steinkerchner et al. (1977), one may form the impression that many of these complaints were due to an abnormally high number of communication line errors (a troublesome but solvable hardware problem) rather than the instructional content of the lessons. Not all of the lesson quality complaints can be so easily dismissed, however, because the quality control procedures were not rigorous and were not systematically enforced. To a large extent, each author was allowed to make his own judgments as to when lessons were ready for student use in the curriculum. Some lessons were tested on members of the general target population, but many were not. Nothing like the validation procedure suggested in the Air Force Instructional Systems Design manuals was applied to the Sheppard lessons. It might well be expected, therefore, that there would be some pedagogical deficiencies in these basically "untested" materials. Nevertheless, it is apparent that perceived shortcomings in lesson quality were only a secondary source of dissatisfaction. The major problems seen by the students had to do with the nature of the experiment's implementation--not the quality of the POMC lessons.

Most of these student complaints seem to stem from a feeling of being in a minority of "guinea pigs" who were being treated differently than their peers. Given the reactive arrangements of the POMC implementation, it is not difficult to understand why they may have held this feeling. Perhaps their anxiety would have been less pervasive had it been possible to assign a larger sample to the POMC condition. If half or more of the students had been exposed to the CBE materials, it is likely that they would have been less con-

cerned about missed class sessions, study of topics in a different order, and uncertainties about curricular organization. Being in the majority, they may not have felt anxiety that they were being treated differently than (and perhaps not as well as) the students in the traditional curriculum.

Why, then, were only one fourth of the students assigned to the POMC? Basically, it was because the high information content and rapid pacing of the PA curriculum led to rigid scheduling of student time. The fixed schedule meant that there were relatively few free hours during which the students were able to use the PLATO terminals. To maximize terminal availability when they might be needed, the project staff decided to assign only one student to the experimental group for each student terminal available. Four of the 20 terminals were used for authors, leaving only 16 for student use. Hence, the experimental group n was set at 16. It should be noted that the rigid scheduling of student time--not the number of terminals--was the true limiting factor. Because the students' time was so structured in the PA curriculum, they couldn't make efficient use of the terminal hours that were available. Other approaches to the scheduling and implementation problem were considered, but were judged to be even more fraught with difficulties than the implementation approach described here.

In summary, the POMC phase was curtailed because of student dissatisfaction with its implementation. The implementation placed a great strain on the experimental group students because they were a minority and were treated much differently than their peers in the regular curriculum. The reactive arrangements associated with the POMC "minority" were necessary because of the fundamental constraints on student time in the PA program. Thus it was these course constraints which were the basic cause of POMC effort's downfall.

Incomplete Development of the POMC

Even if there had been no "mutiny" as the first class of POMC students completed the second trimester of their program, it is not certain that the remaining third trimester lessons would have been completed in time. The fact that lesson production rates fell behind schedule must therefore be the second major project outcome to be considered.

The original research agreement stated that 200 hours of CBE instruction would be developed for the problem-oriented curriculum. Later, at the time it was decided to focus on the topic of respiration, the staff reduced the total to 145 hours. This was felt to be justified in that the 200 hour figure had been arbitrarily selected and because the smaller figure represented approximately 10% of the 1400 hours comprising the first year of the PA program. According to the implementation plan (see Appendix B), the 145 Plan of Instruction hours were to include 121 hours of clinical and basic science materials distributed throughout the year (i.e., 24, 25, and 72 hours across the three trimesters, respectively). In addition, there were to be 24 hours of patient encounter simulations which had no counterpart in the regular PA curriculum.

By the end of July, 1975, however, there had been a further reduction in the amount of materials to be developed. A project document prepared for ARPA indicates that 104 hours of clinical and basic science lessons (22, 29, and 53 hours for the 1st, 2nd, and 3rd trimesters, respectively) were planned. These, plus the 24 hours of patient encounter simulations, gave a projected total of 128 POI hours of materials.

The report prepared for ARPA also gave estimates of the actual clock hours to be consumed in studying the CBE materials. Whereas the earlier estimates had been reported in terms of POI hours allotted in the course documents for the

respiratory topics, the project staff believed that fewer clock hours would be needed for the CBE lessons. To arrive at the estimates of clock hours, the staff assumed that 25% of the POI time could be saved because progress through the POMC would be self-paced rather than lock step. They also assumed that an additional 15% could be saved with CBE as compared to other self-paced media. Without questioning the basis for these assumptions, it is interesting to note that the staff projected 11.4, 13.1, and 24.2 clock hours of replacement POMC lessons to be used in the first, second, and third trimesters, respectively. These values are considerably smaller than their POI hour counterparts given in the same document (i.e., 22, 29, and 53) or in the implementation plan itself (24, 25, and 72). No separate clock hour estimates of the quantity of simulated patient encounters was offered; the original estimate of 24 POI hours was not modified.

While the reduction in scope of the project and the problem of whether to describe it in terms of POI hours or clock hours are interesting observations, it is more important to examine the proportion of the total materials that were completed. In July, 1975, the Sheppard staff reported that while 81% of the first trimester lessons had been finished, only 36% of the second trimester and 18% of the third trimester lessons were in a usable state. The remaining lessons apparently were in various stages of completion at that time.

No mention is made by Steinkerchner et al. (1977) as to the proportion of the lessons that had been completed at the time the POMC was terminated. Since the first and second trimester materials were the first needed for student use, it may be assumed that the development effort was concentrated on getting those lessons produced. If they were completed (and we don't know that they were), it would have left the bulk of the third trimester lessons to be developed in a relatively short period of time. Had the POMC phase been

continued, it is conceivable but not likely that the third trimester lessons could have been completed in time. Based on our observations of the time spent by the Sheppard staff in completing earlier lessons, the task of finishing the 53 POI hours of clinical and basic science materials plus the remaining cases in the series of simulated patient encounters would have required lowered standards of quality, more superficial coverage of topics, and even more hours of overtime work per day than had already been logged.

The extreme time pressure to complete the POMC lessons posed a continuous and vexing problem to the project staff. There were a number of underlying factors to this plight, not the least of which was an unrealistic expectation at the start of the project as to the time required to produce a given body of materials. In the original request for training research (see Appendix A), the project initiator assumed a production rate of 300 hours of author time to research, develop, and test each student contact hour of CBE materials. (This in itself is not necessarily a bad initial estimate.) He then went on to compute a total time requirement of 60,000 author hours to produce 200 hours of material and, assuming a three year project and 2000 work hours per man year, determined that a manpower requirement of ten authors was established. Again, there are no problems with the fundamental arithmetic of these calculations. However, this analysis failed to take account of other non-authoring duties of the staff and, more importantly, the fact that the proposed project milestones only allowed 18 months for development prior to the start of the evaluation phase. Clearly a staff of 10 should not have been expected to produce 200 hours of new materials in an 18 month period. The job was too big for the number of people assigned to the project even if there had been no hitches.

Unfortunately, the effort was plagued by several time-consuming problems in its initial stages. First, the project initiator left the project just at the time it was officially getting underway. Since he was the originator of the POMC concept at Sheppard, his departure left the PLATO staff to struggle on its own in interpreting and redefining the project's goals.

The definition process was complicated by the staggered arrival of key staff members. Although the project approval date was November, 1973, the physician chosen to serve as subject matter specialist and curriculum planner did not join the staff until July, 1974. Many important decisions about the curriculum were postponed until his arrival, and because the choices he made amounted to a change in the project's goals, the planning and lessons developed to that point were not utilized. Even after the physician's arrival, there was a shortage of manpower for lesson development. Four of the ten staff members identified had yet to join the project, with the last not arriving until November, 1974.

Perhaps the next most tangible factor underlying the failure to complete the POMC was the decision to use only one fourth of the PA class in the experimental group. Realizing that an n of 16 was dangerously small, the staff decided to replicate the experiment with a second class of PA students to start the sequence the following trimester. But in order for two classes to have time to complete the entire POMC within the scheduled evaluation period, it was necessary to move the start of the implementation forward to July, 1975, reducing the time available for lesson development by six months. The scope of the task had been reduced somewhat by this time with plans to develop 145 POI hours of CBE materials rather than the 200 contact hours originally proposed. Nevertheless, the task was still too large to be completed in view

of the late arrival of the staff and the severely compressed time schedule forced upon them by the scheduling constraints of the PA students.

There were other factors which had subtle but real effects on the project's rate of lesson production. One of the more important of these was the fact that many of the authors were considered to be basic scientists having a well-defined subject matter specialty (e.g., chemistry, anatomy, pharmacy, clinical psychology). Although each was a subject matter expert in his own right, most lacked the broader perspective afforded by clinical experience. Placed as they were in a situation of trying to present material in a clinical context (i.e., illustrating its clinical relevance), these basic scientists were at a real disadvantage. They had to depend on the physician and another staff member who was a recent graduate of the PA course for assistance in this regard. Because the basic scientists had limited experience in medical/clinical matters relating to the respiratory system, they had to spend a great deal of time in researching and organizing the topics they were teaching, and hence they were unable to develop materials as rapidly as they otherwise might have. This problem came about because the objectives of the project were changed after its inception, although staff was selected and hired on the basis of the original goals.

Other problems hindering the lesson development process included a general lack of experience/training in instructional design procedures, the fact that only two staff members had taught portions of the PA course before, only three persons had previous teaching experience, and none had had previous experience in designing a curriculum. It might also be said that talents of some staff members were not fully utilized in lesson production. The Instructional Systems Development

specialist, the illustrator, and one of the experienced computer programmers probably could have been utilized more fully in an overall team effort for production.

In summary, the task of developing and implementing such large amounts of new curriculum materials was highly overambitious and unrealistic given the manpower limitations and time constraints imposed on the project. Progress was further limited by the staggered arrival of staff, the change in project goals implied by a reinterpretation of the POMC concept, the fact that the basic scientists' subject matter expertise was nullified by the decision to focus narrowly on one organ system, and failure to utilize fully the talents of the available staff. It was only through much hard work and many overtime hours that the staff was able to complete as much courseware as they did.

Difficulty of Defining the POMC

The third major outcome of the Sheppard project's initial phase was that not much was learned (or at least not much was documented) about the nature of the POMC concept and its feasibility. It is not clear that the curriculum that was implemented was truly problem oriented.

The person most knowledgable about the original concept of a problem-oriented reorganization of the Physician Assistant curriculum, the project initiator, left the military just at the time the Sheppard CBE project was given official approval. The primary document which we have available describing his conception of the POMC is the Request for Training Research (see Appendix A). Unfortunately, because of its brevity that document does little to edify the reader regarding the original view of what would constitute a POMC. A later document (22 June 1973) outlined a reorganization of the entire first year of the PA program under a group of 24 sets of

patient complaints. Under this scheme, the problem presented by the patient would serve as a touchstone for instruction in basic science and clinical material relevant to that particular set of symptoms.

By the time of the February, 1974, planning session at Sheppard AFB, the PLATO staff and other SHCS representatives had decided not to convert the entire PA curriculum to a problem-oriented (symptom-oriented) format, citing the sheer size of the task as being beyond the scope of the project. Instead, they adopted the following working definition of the POMC (Kimball, Note 1).

> A problem-oriented curriculum is the grouping of course content under clinical problems and the presentation of material in a clinically-oriented mode such that the clinical relevance of the course content is stressed in order to develop problem solving skills, patient management and investigative skills, and the collection of a medical data base.
>
> Included in this curriculum are certain basic science materials that cannot be directly related to clinical problems. This material will be included in the curriculum as prerequisites to bring students up to a minimal acceptable level of knowledge. To the maximum extent possible this material will be presented in such a way as to contribute to the development of problem solving skills through the use of inquiry learning techniques.

A passage from a later document (dated August, 1974) reflects the staff's decision to focus on topics relating to the respiratory system. While it is consistent with the working definition of a POMC quoted above, it provides some additional insight as to the project's evolving plans.

> Patient problems (i.e. the symptoms or complaints for which medical attention is sought) will be defined and used as a point of departure to teach the basic and clinical science material related to the Respiratory System.
>
> This will lead to student-computer interaction to solve a variety of clinical problems (i.e. exercises in differential diagnosis and therapeutics).

> Thus, the curriculum will be composed of a number of integrated, but potentially free-standing lessons dealing with the basic and clinical sciences as well as simulated patient encounters. The student will have access to basic and clinical science review material from anywhere within the lesson sequence.

The last portion of this statement emphasizes the staff's expectation that students would be able to branch back to study or review basic science material relevant to specific cases.

A September, 1974, document gave the following elaboration of the group's interpretation of "problem orientation":

> The term "problem-oriented curriculum" has been taken to mean several things: (1) a clinically relevant curriculum heavily based on case descriptions, using those both as a point of departure and as a point of reference for teaching the associated medical material. This naturally implies (2) an integrated approach including the areas of anatomy, microanatomy, biochemistry, genetics, immunology, neuroscience, physiology, pathology/pathophysiology and clinical medicine, pharmacology/therapeutics, and laboratory techniques. In addition, there will be practice in solving clinical problems (making diagnoses and treatment plans for simulated cases).

Yet another descriptive statement is given in the POMC Implementation Plan. Although the entire plan is included as Appendix B, the relevant section is restated here to aid comparison:

> A problem-oriented medical curriculum is defined as the grouping of course material under clinical topics where the clinical relevance of course content can be stressed. Emphasis is placed on developing problem solving skills in diagnosis and treatment of disease. To facilitate development, the POMC has been divided into two parts. Part I presents the relevant basic science and clinical material in an integrated manner supported by illustrative case material and using clinical subjects as point of departure to teach basic sciences. Part II will consist of "Simulated Patient Encounters" which will be approached as unknowns by the students. Diagnostic and treatment skills as well as clinical problem solving skills will be amplified in Part II.

All of these statements are fairly similar, but the subtle differences may be particularly important in view of later author confusion and disagreement over what a problem-oriented curriculum should entail. As one author said, "There are as many definitions of 'problem oriented' as there are authors." It is readily apparent that the staff did not prepare a carefully-stated operational definition of the POMC which would serve as a touchstone for all development efforts.

The importance of clinical relevance is stressed in all of these statements, but they differ as to what place clinical cases should have in the curriculum. This was a substantial point of author disagreement. Authors did not agree on the question of whether individual lessons must necessarily include cases (or clinical references), or even problem-solving elements.

One author thought that a curriculum which included patient simulations could thus be considered "problem oriented" regardless of whether other lessons in the curriculum centered on clinical cases or conditions. According to this criterion, Sheppard's curriculum was indeed "problem oriented", as would be any others which include case simulations!

Other authors thought the curriculum should proceed backward from clinical cases to the basic science material necessary to diagnose them, finally ending in having the student diagnose simulated cases.

In a thorough review of those lessons known to have been studied by PA students, we determined that only about seven percent included clinical cases or simulations. The project staff outlined the following criterion for a "problem-oriented curriculum in a September, 1974, document: " ... a clinically relevant curriculum heavily based on case descriptions using those both as a point of departure and as as a point of reference for teaching the associated medical material ...".

According to this standard, the Sheppard curriculum would probably not be considered problem oriented because such a small fraction of lessons fit this description.

Several factors contribute to this problem. First, changes in project administration and the delayed arrival of the senior content expert (who exercised authority over curriculum definition and development), resulted in considerable rehashing and revamping of both the definition of "problem orientation", and the implementation plan itself. For example, in the summer of 1974, when the final group of Sheppard staff visited CERL for training in the TUTOR language, they reported that the definition of "problem orientation" was still being determined. This was nearly a year after the inception of the Sheppard project.

Second, due to the lack of firm administrative policy or control, authors exercised their own judgment over what "problem oriented" meant, and how that related to their own lessons. Consequently, there is little curriculum uniformity either in terms of "problem orientation" or in the approach to (or necessity for) teaching problem-solving skills.

In a memorandum summarizing the discussions and decisions made during the February, 1974, planning session, the acting project director said that the " ... primary objective of the project is to reach some conclusions regarding the instructional effectiveness of the 'concept' of a problem oriented curriculum" (Kimball, Note 1). Judging from the variety of perceptions of what constituted a POMC, the "concept" of a problem-oriented curriculum was never clearly defined. It is our belief that, in the absence of unambiguous criteria for determining what would and would not qualify as a POMC, the question of the instructional effectiveness of the POMC "concept" could not have been determined even if all lesson materials had been completed and properly implemented.

Limitations of the Evaluation Plan

A fourth major area for analysis among the outcomes of the POMC phase is that of the planning and execution of the evaluation. Since a major goal of the project was to evaluate the concept of a POMC, it is important to examine the plans and procedures that were to be applied.

Several points regarding the evaluation plans and staffing are noteworthy. First, there was a shortage of evaluation expertise on the project staff. The person who was designated as the evaluator was a clinical psychologist who had come to the project with the expectation that he would work as an author on those curriculum topics having to do with the psychology of patient care. When the project's goals were defined more narrowly in terms of respiratory topics, this individual was assigned the responsibility of designing and implementing the evaluation. He had very little formal training in data-based evaluation procedures, but was, of course, well trained in observation and interview techniques. These skills proved quite useful in diagnosis of student complaints and in determining their reasons for asking to be dropped from the POMC condition.

Perhaps because of the relative lack of local evaluation expertise, the Sheppard project staff had the continuing expectation that representatives of other agencies would supplement their own evaluation efforts. In particular, it was believed from the outset that AFHRL would take an active role in structuring and carrying out the evaluation. According to the Research Agreement, AFHRL project monitors were to assist in the measurement of student and instructor attitudes as well as student performance. This expectation was reinforced at an August, 1974, evaluation conference hosted by AFHRL. Furthermore, it was learned at this conference that ARPA had contracted with the Educational Testing Service (ETS) to con-

duct an overall evaluation of the use of the PLATO IV system at ARPA-supported military training sites (this responsibility was later given to CERL's MTC and PEER groups. As part of its evaluation role, ETS was to prepare a list of clinical problems and to assist in the measurement of clinical problem-solving skills. These hopes were later made more specific, as can be seen in the POMC evaluation plan (Appendix C). According to this plan, ETS was to provide items for an examination covering respiratory disease. If insufficient items were available from ETS item banks, yet another outside agency (the University of Nebraska Physician Assistant program staff) would be called upon to supply items. ETS was also expected to provide some "simulated patient encounters" in paper-and-pencil form to be used to measure clinical problem-solving skills of both the POMC and Control group students.

It is clear from Appendix C that the Sheppard staff was banking heavily on support from outside agencies and that they were willing to assume that these agencies would be able to carry through on their assigned responsibilities. It should be noted, however, that at the time of the preparation of the evaluation plan (March, 1975) very little work had been completed toward the assembly and development of the measurement instruments. This was in spite of the fact that the evaluation period was to begin in July, 1975.

The evaluation plan itself called for nine studies. These were: (a) a comparison of POMC and Control groups' academic knowledge (of respiratory material), (b) a comparison of their problem-solving skills, (c) examination of the POMC group's attitudes toward computer-based education, (d) monitoring of the POMC group's performance on lesson and block exams, (e)-(g) studies of authors' performance, attitudes/opinions, and characteristics, (h) summary of costs, and (i) a study of the reliability of the PLATO IV system and terminals.

Had they all been completed, these nine studies would have addressed worthy evaluation goals. However, it is doubtful whether many of them could have provided much generalizable information. There are several reasons for this assessment.

In the case of the comparative study of academic knowledge, for example, the sole basis for comparison was to be a comprehensive test over basic science and clinical concepts relating to the respiratory system and its diseases. The plan called for some empirical development work in the construction of the test, but it is not clear that sufficient work could have been done in the allotted time and with the available subject pool to assure adequate reliability and validity for the desired purposes. When such heavy reliance is placed on a single instrument, it is essential that sufficient development effort be invested.

Another set of concerns underlying the academic comparison study is that it was to be conducted under highly reactive arrangements. Because the implementation constraints allowed for such a small n, the POMC group was treated much differently than the Control group in regard to scheduling and testing. These reactive arrangements created additional stresses for the POMC group which may have interfered with (or enhanced) that group's learning of the target material; hence, the reactive arrangements represent confounding factors which would have made interpretation of comparative results quite difficult. Other potentially contaminating influences can be traced to the small-group study patterns followed by the PA students. It is likely that POMC and Control group students studied together in the evening hours and on weekends. If so, it is quite possible that there was a sharing of notes, recollections, etc. which may have acted to "wash out" any differential treatment effects. Although it is reasonably certain that Control group students did not actually study

POMC lessons on the PLATO system, they may have had some vicarious experience with them through their friends in the POMC group. It is even more likely that the POMC students may have studied lecture notes for those classes they had "missed" while attending POMC sessions in the PLATO classroom. At any rate, without adequate controls to assure the "purity" of the treatment conditions, it would be difficult to interpret the results of the comparison or to generalize them to other settings. Furthermore, because the POMC was administered entirely on the PLATO system and the Control curriculum was presented entirely by traditional lecture approaches, there was a complete confounding between strategy (i.e., problem-oriented versus traditional) and mode of presentation. Had one group outperformed another on the academic test, it would be unclear whether it had been because of differences in curricular approach or differences in presentation medium. This PLATO-POMC confounding was a pervasive problem and one which was not addressed by Sheppard's evaluation plan.

Of the remaining eight studies that were planned, only those dealing with authors' performance, attitudes/opinions, and characteristics are singled out for comment here. As a whole these studies represent legitimate areas of inquiry, but because of the complexity of such notions as "author performance" and "author attitudes", they are very difficult to pursue systematically. For example, author performance was to be measured by judgments of lesson quality, supervisory ratings, and peer ratings. The dimensions of TUTOR language programming ability, lesson design efficiency, and creativity were to be the primary indices of "performance", and it was to be the task of AFHRL researchers to develop suitable scales and measures. To our knowledge, this particular study was not seriously attempted--perhaps because of the great difficulty in defining and measuring these dimensions. Likewise, we know of no significant effort to measure author attitudes.

A number of aptitude test scores and other data were assembled on the author group to identify certain key characteristics, as it was hoped that these could be used to predict what kinds of individuals should be selected as authors for future projects. However, because these individuals had already been selected and were functioning on the job, it does not seem likely that they would vary widely in easily-measured dimensions. Even if some relationships had been found between author characteristics and performance in this selected group, they may not be valid for choosing from the general population of candidates. The goal of this study was a worthy one, but it is not clear that much of predictive value could have been learned from such a small sample of authors. Perhaps this is why the results of the study were not reported by Steinkerchner et al. (1977).

In addition to these criticisms of what was planned for the evaluation, we can also point to some areas of omission. It is clear that the staff believed their primary goal was to evaluate the effectiveness of the POMC; they did very little to evaluate the effectiveness of its implementation. Because of the many problems in defining and developing the new curriculum with a new medium under tight time constraints and the rigidities of the PA course, the project was really one of attempting to initiate a number of innovations in a highly traditional and structured environment. One of the prime targets of opportunity in such a setting is the documentation of procedures used in installing the innovations. In the POMC evaluation plan, however, there were no provisions for describing the communications between the project staff and members of the PA staff. Furthermore, Steinkerchner et al. (1977) did not report on those important transactions. The likelihood of failing to examine unanticipated outcomes is one of the major drawbacks to a preordinate approach to evaluation.

A second area of opportunity that was not sufficiently tapped in the POMC evaluation was that of determining those military training applications for which the PLATO system would be particularly well suited. The primary goal of the project was to implement and test a prototype problem-oriented curriculum. The PLATO system was treated as a given--a medium that had already been proven--rather than as an important component of the overall innovation. It is true that the plans provided for an assessment of costs and reliability of the PLATO system, but they did not provide for a determination of its strengths and weaknesses for medical education. One result of the staff's seeming acceptance of PLATO as an established medium is that they implemented all POMC instruction on the PLATO system. For example, they did not differentiate between instructional units that required large amounts of interaction and those that did not--all were created in the form of CBE lessons. In contrast, it should be noted that the plans for Phase II (see Appendix D) called for a much closer examination of the medium and its suitability for use with various types of students and instructional tasks.

In summary, the evaluation of the POMC phase reflected the constraints imposed by the PA course and the implementation plan adopted to accommodate those constraints. The evaluation plan was conceived to fit the situation rather than defining the situation to ease the evaluation process and increase the usefulness of its findings. The staff put together a plan that fit the circumstances, but their job was made more difficult by their own inexperience and their resulting dependence on other agencies. Furthermore, because of the severe constraints of the course and the narrow definition of evaluation targets (e.g., effectiveness of the POMC with little emphasis on the transactions involved in its implementation), the generalizability of the evaluation results would have been limited even if the POMC phase had not been terminated.

Additional Outcomes

Relations between PLATO staff and PA staff. As indicated earlier, the communications between the PLATO staff and the PA instructors were not a target of the SHCS/AFHRL evaluation. Because CERL did not have access to the PA instructors to conduct interviews, MTC's information about their attitudes toward and experiences with the POMC phase is also limited. However, through our discussions with the Sheppard staff we have gained the general impression that communication with the PA instructors tended to be sporadic and superficial. Many of the PA instructors apparently perceived the POMC/PLATO project as being a temporary and experimental arrangement having no long-term impact on the operation of the PA program. Consequently they showed little interest in the project and maintained a neutral or mildly negative attitude toward it. Initially there was to be a representative from the PA staff present at the PLATO project staff meetings. Likewise, the PLATO group was to send representatives to the PA staff's meetings to act as liaison. However, the importance of maintaining good communications between the two groups must not have been fully appreciated, because the frequency of "joint attendance" at meetings soon dropped nearly to zero.

Not only did the formal channels of communication remain underutilized or ineffective, a number of informal approaches also had limited success. A test grade averager and on-line grade book was prepared by one of the PLATO staff to help the PA instructors with the mechanics of grading (made more difficult by the separate make-up exams for the POMC group). In spite of its apparent convenience, it went unused and unappreciated by the instructors. Individual authors would often go to their counterpart on the PA staff and enlist his or her help in reviewing a lesson corresponding to a lecture. Though the PA instructors were generally cooperative, they tended to

view the PLATO materials as a nice adjunct but not as a replacement for the lectures. In a few cases there were some disagreements about the depth of coverage that should be given. These arose out of the ambiguity of the course's Plan of Instruction and a changing conception of the role of a PA. In general, however, the instructors did not play a large role in determining the content and strategy of the lessons.

It is not known how much the PA staff's apathy may have affected the students' attitudes or performance, but it was probably not a positive influence. A more systematic cultivation of relationships with the PA staff might have helped generate a more favorable attitude and greater cooperation. On the other hand, given the fundamental conception of the project as an experimental implementation of a new and unproven style of curriculum, the PA staff may not have been "won over" to an enthusiastic and positive outlook no matter what techniques were used.

Interactions between MTC and Sheppard staffs. The MTC group (through its specially-designated subgroup "Shp East") was given a contractual role by ARPA to provide support to the Sheppard staff and to participate with them in development of the POMC. The sponsor had visualized MTC's role as one of active participation--particularly in those areas of the project where the MTC staff's experience could lead to significant time savings (such as in developing the programs to implement the simulated patient encounters). A graduate of the SCHS Physician Assistant program was assigned by the Air Force to work directly with MTC staff members as a subject matter expert. It was hoped that his presence at CERL would enable the MTC staff to contribute directly to project planning and development.

Although working relationships between the MTC and Sheppard staffs were congenial and productive, there was a reluctance on the part of the Sheppard group to give MTC

the role of co-participants outlined in the contract. This may have been partly due to concerns about MTC's lack of specific subject matter expertise (accentuated by the early departure of the PA assigned to assist at CERL). Another obstacle was the geographic separation between Sheppard AFB in Wichita Falls, Texas, and CERL in Urbana, Illinois. Thus, with some exceptions, MTC's role on the project turned out to be one of providing advice and support rather than one of direct participation.

If it was difficult for the Sheppard staff to consider MTC as co-participants, it was even harder for them to accept MTC/PEER inputs and participation as evaluators on the project. The primary intent of the sponsor was for evaluation staff at CERL to work to enhance the effectiveness of Sheppard's efforts. It seemed, however, that the Sheppard group perceived CERL's evaluation role at that stage as being summative rather than formative. They were uncomfortable with the notion of "being evaluated" by a group that had previously been in a support role as "co-participants". As a result, a considerably less interactive role was negotiated with ARPA for MTC and PEER than had been originally anticipated.

In general, the impact of CERL's involvement with the Sheppard project was significant, but probably not as great as it might have been. Perhaps the greatest factor limiting MTC's influence was the geographical separation between CERL and Sheppard AFB. Other obstacles to collaboration (e.g., differences between military and civilian methodologies and MTC's lack of medical subject matter expertise) would have been less troublesome had the two groups been in closer proximity. For example, the Sheppard staff stated that MTC reviews of their lessons would have been more helpful had the reviewers been located at Sheppard (Call-Himwich, 1977a).

OVERALL ASSESSMENT

Summary of Major Outcomes

The most important (or most visible) categories of outcomes of the POMC phase were discussed in the previous sections. Of these, the most tangible was the move by many of the POMC group students to be dropped from the experimental condition. The primary basis for their request was a dissatisfaction with the implementation of the POMC vis-à-vis the regular portions of the PA curriculum. Being a minority of only one fourth of their class, the POMC students felt threatened by an implementation which required them to "miss" lectures attended by the majority of their peers. The make-shift testing and examination procedures were also a source of discontent. Another complaint was that the POMC appeared to be fragmented and lacking in continuity. This, of course, was a further result of the perceived necessity to replace discrete hours of the regular course with new materials from the POMC. Some problems having an impact on student attitudes grew out of the time pressures on the staff and hence were only indirectly related to the implementation. These included an unfortunate introduction to the project (in which privileges were first offered and then withdrawn) and programming errors in relatively untested (and unvalidated) lessons. It is difficult to assess the impact of the latter problems, but we believe them to be secondary in importance to the fundamental constraints on the implementation imposed by the PA course itself.

The second major category of outcomes was the complex of factors which impeded lesson development progress. We believe that the POMC lesson materials may not have been ready in time for use even if the first project phase had not been terminated early. As detailed above, several factors contributed to this situation. They include an unrealistic

assumption about the amount of materials that could be produced in a given time period, the late and staggered arrival of staff members, a severely compressed time schedule due to the desire to run a second group of 16 students, and a change in project goals which made it necessary for some staff members to write materials outside their own specialties, hence decreasing their efficiency.

Another clear outcome of the first project phase was that the concept of a problem-oriented curriculum was not operationally defined. After the project initiator had left the service, it was up to the remaining staff members to settle on a definition of the POMC. They never did. Although work on a definition began in February, 1974, and continued throughout that year, there was still enough disagreement at the end of the first phase that one staff member stated that "there are as many definitions of 'problem oriented' as there are authors." In view of the unresolved ambiguity as to what constitutes a problem-oriented curriculum, it is not clear that Sheppard's Phase I materials qualified as a POMC. Had that phase run to completion, it would have been difficult to judge whether or not the concept of a problem-oriented curriculum had been implemented and tested.

Furthermore, even if the student sample had not diminished to the verge of extinction, if the POMC lessons had been completed, and if they had been truly representative of the concept of a problem-oriented curriculum, there were several deficiencies in the planning and conduct of the evaluation which would have limited the generalizability of the results.

Conclusion

It is clear that the POMC phase of Sheppard's PLATO project did not meet its objectives. Unfortunately, the innovative nature of the POMC concept may have been more suited to

evolutionary development than to the systems approach that was attempted. It is now apparent that too little was understood at the outset about the POMC concept and how it should be implemented to guide the project's development. This was not clear at the beginning, however, and the negative outcomes could not have been foretold. In spite of its early termination, the POMC phase was a worthy effort--a number of lessons were learned which provided a firmer basis for the follow-on project.

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APPENDIX A

Request for Training Research

REQUEST FOR TRAINING RESEARCH

1. FROM: School of Health Care Sciences, USAF
Charles N. Mullican, Lt Col, USAF, MC
Sheppard AFB, Texas 76311
Autovon: 736-2210 4 April 1973

2. TITLE: Evaluation of PLATO IV System in Air Force Medical Training

3. PROBLEM: A critical shortage of physicians' services exists in the USAF Medical Service, reflecting a similar nationwide deficit. Traditional modes of health care delivery have been maximally stressed and found inadequate; new categories of health manpower have been developed. One such new health professional is the physician assistant (PA), a person who because of special training and experience can perform many duties formerly carried out only by physicians.

The allied health education of the Physician Assistant and the medical education of the physician are remarkably similar in content and scope, therefore most PA programs are modeled after traditional medical school curricula. The instructional approach is characteristically one in which there is a horizontal sequencing of basic medical sciences with clinical practice. The usual modes of teaching and learning are lecture/demonstration in group/lock-step pattern. The major difficulty with such a curriculum is that the core of medical knowledge which must be memorized is usually taught without a fundamental frame of reference. Basic medical sciences are often presented in isolation from their clinical relevance, both intellectually and temporally. Thus, when the clinical sciences are ultimately presented, time-consuming and repetitious review of the basic sciences must precede the teaching of a new body of knowledge.

The basic frame of reference missing in a traditional medical curriculum is the core of clinical behavior which characterizes the problem-solving process. Its absence has heretofore made the application of recent advances in educational technology (systems analysis and design) difficult and inconsistent.

4. OBJECTIVE: Two major objectives of this study are envisioned: (a) The research and development of a new, problem-oriented, medical curriculum at the physician assistant level using an advanced, computer-based educational system and (b) a comparison evaluation of the instructional effectiveness of this curriculum vis-à-vis the present traditional curriculum.

5. BENEFITS:

a. Advanced Research Projects Agency: To make available the development of a fundamentally new problem-oriented curriculum upon which all allied health instruction nationwide can be constructed. This prototype would have the potential for the complete reduction of all present time-consuming, repetitious and costly instructional practices.

b. Department of Defense: To provide an instructional test bed for the new generation of military hospitals project.

c. USAF/SHCS: To make available a comprehensive computer-based educational system for use in training and educating allied health professionals in the USAF medical service through the utilization of existing PLATO IV programs as well as connection with the tie into other computer-based networks.

d. University of Illinois: To provide CERL's PLATO IV project with all the necessary requirements for the research and development of the types of hardware necessary to meet the unique requirements of the medical education system by providing the data base, Instructional Systems Design, test students, and evaluation protocol.

6. MAJOR USERS:

a. SHCS

b. Other uniformed services

c. Civilian educational institutions

d. NGMH

7. TIME PHASING:

a. Project development: Approval data + 18 months.

b. Test evaluation: Approval data + 30 months.

c. Final report: Approval data + 36 months.

8. UTILIZATION CONCEPT:

Because the development of a new curricular approach is an evolutionary process, it is difficult to foretell the state of the art at the time of Final Report. Nevertheless, it is conceivable that the man-machine interface will result in a continued reinforcement of the problem-solving process as the dominant mode of clinical behavior. Instructional modules will be used to teach a basic core of medical knowledge as it relates to clinical problems. This core of knowledge will be

available for other allied health personnel to aid in understanding their own roles in the delivery of health care, that is, their place along the diagnosis-treatment loop. Concurrently operating will be a continuous evaluation of the relative merits of the two curricula, with and without PLATO IV.

9. BRIEF OF THE PROJECT: a. Approach

(1) Givens:

(a) A basic core of medical knowledge for USAF Physician Assistants exists as outlined in the Plan of Instruction, Course 3ALR91730, dated 3 August 1972 (Appendix A).

(b) A basic pattern of clinical behavior characterizes problem-solving which is straightforward, logical, and scientific.*

(c) A charting system exists for recording and documenting the use of medical knowledge in the solving of clinical problems.

(2) Assumptions:

(a) Advances in educational technology and instructional systems analysis can be greatly aided by a computer system in which [9a(1)(a) and (b)] (above) are integrated and correlated.

(b) Such a system will be self-paced and learner-oriented. Evaluative systems will constantly assess the effectiveness of instruction and the level of student achievement. Quality instruction and performance will not be compromised in deference to resources conservation.

(3) Methodology

(a) Approximately 200 student contact hours of new curricular material will be developed on the University of Illinois' CERL's PLATO IV system.

(b) An Instructional Systems Design IAW AFM 50-2 will be developed and the rough outline of a problem-oriented curriculum will be programmed into PLATO IV.

(c) During the development of this project, students will be exposed to both curricular formats in which PLATO IV may or may not be employed. The suitability and contribution of computer-assisted instruction will be evaluated as it stands alone and vis-a-vis the curricula.

(d) The attached management guide for a patient entering the emergency room confused or in coma (Appendix B) illustrates how the problem-oriented approach may be used to organize curricular material into data gathering (Subjective information and Objective data), data synthesis (Assessment) and problem resolution (Plans). At virtually every point along the problem-solving loop, branching into the body of basic and clinical medical knowledge can be made; for example, while studying the data base contained in Subjective information, the student can review methods of interviewing, pertinence of questions to be asked, and so on. When reviewing the information to be gathered under Objective data, the student can correlate anatomy, physiology, radiology and techniques of physical examination. Under Assessment, the student is appropriately exposed to classic descriptions of disease processes which can be integrated with presentations in pathophysiology and biochemistry. When learning of the problem-resolution phase (Plan) the student is exposed to the fundamentals of laboratory medicine (clinical chemistry, microbiology, serology, and so on). Additionally, pharmacology is rationally interpolated at this point to describe the basic knowledge underlying medical therapeusis.

(e) It is apparent that such an approach stresses the importance of a certain pattern of clinical behavior and it is this critical area that will be subjected to intensive evaluation as to the role of CAI in developing and maintaining desirable attitudes and dispositions.

b. Support required

(1) Personnel

300 hours author time (AH) are required to research, develop and test 1 student contact hour (SH).

200 SH = 60,000 AH.

1 man-year = 2000 hours.

Therefore 200 SH = 30 man-years.

For a three-year project, a need of 10 persons is established.

(2) PLATO IV terminals: 20 (15 student, 5 author).

(3) Dedicated telecom lines: 5

(4) Advisor-consultants at the University of Illinois: 2

(5) Physical plant and equipment

(a) 20 carrels

(b) Adequate air conditioning to keep units sufficiently cool (20,000 BTU per terminal).

(6) Installation and maintenance of PLATO IV equipment at SHCS.

(7) Training of ten SHCS personnel at the University of Illinois in TUTOR language, curricular development and instructional capabilities of PLATO IV.

10. SUMMARY: A new curricular approach to the teaching and learning of problem-oriented health care, systems analyzed and developed in conjunction with an advanced computer-based educational system, is described. The impact upon allied health education at the SHCS is all-encompassing since such a curriculum offers an understandable frame of reference for health care delivery as it relates to the responsibilities of each training department. The research design will attempt to provide significant data comparing the effectiveness not only of the differing curricular approaches but also of computer assisted instruction in health education.

*Hurst, J. W. and Walker, H. K.: The Problem-Oriented System, MEDCOM Press, 1972, 287 pages

APPENDIX B

POMC Implementation Plan

POMC IMPLEMENTATION PLAN

I. References: Course Chart 3ALR91730 10 Feb 1975
POI 3ALR91730
Research Agreement "Evaluation of PLATO IV System in Air Force Medical Training"

II. Plan Objective

The purpose of this plan is to provide for the orderly integration of the Problem Oriented Medical Curriculum (POMC) developed by the PLATO IV Development Branch into the present Physician Assistant curriculum. This integration will be done in such a way that:

1. Disruption of the present curriculum is minimized.

(a) Steps will be taken to insure that prerequisite material is taught prior to the time it is required as a basis for other material.

(b) The logical flow of content in discipline oriented blocks will not be jeopardized.

2. The integrity of the POMC is maintained, i.e. presentation of material is not excessively fragmented.

3. No degradation in training will result.

4. Evaluation of the POMC is facilitated.

III. Scope

This plan pertains only to the Physician Assistant Course (Phase I), 3ALR91730. The time frame for implementation of this plan is Jun 1975 - Oct 1976 to correspond with the evaluation phase of the PLATO IV project.

IV. Background

A. On 4 Apr 73, the School of Health Care Sciences submitted a proposal for personnel research to Hq ATC. The resultant research agreement calls for (1) the research and development of approximately 200 hours of a new problem oriented medical curriculum at the physician

assistant level, using an advanced computer based education system, and (2) the evaluation of the instructional effectiveness of this curriculum vis-à-vis the traditional curriculum. The project covers a three year period beginning in November 1973. Evaluation is to be completed by 1 July 1976, with the final report to be rendered in November 1976.

B. A problem oriented medical curriculum is defined as the grouping of course material under clinical topics where the clinical relevance of course content can be stressed. Emphasis is placed on developing problem solving skills in diagnosis and treatment of disease. To facilitate development, the POMC has been divided into two parts. Part I presents the relevant basic science and clinical material in an integrated manner supported by illustrative case material and using clinical subjects as point of departure to teach basic sciences. Part II will consist of "Simulated Patient Encounters" which will be approached as unknowns by the students. Diagnostic and treatment skills as well as clinical problem solving skills will be amplified in Part II.

C. The task of selecting the content of the POMC from the massive amount of material included in the present physician assistant course was undertaken as follows. Selection was based on the criteria that the clinical area would (1) accommodate an integrated approach to include both the basic and clinical sciences, (2) contain fairly circumscribed and clinically relevant subject matter, (3) provide sufficient subject matter to meet the project objectives, and (4) make the best use of resources within the PLATO IV Development Branch. Jointly exhaustive lists of possible etiological and body systems were tested against the

selection criteria. The respiratory system (respiratory disease) was selected as the best subject area for the purposes of this project.

D. A list of basic sciences and specific clinical topics has been developed and arranged in a curricular structure which defines the basic sequence and interrelationships of the subject matter areas. Initial planning/programming has begun in eight of the proposed 20 lesson development areas.

V. Approach to Implementation

A. Definitions and Constraints

1. Terminals. There are 16 PLATO IV student terminals. Prime time (when the system is most stable) is from 0740 to 2200 hours, Monday, Wednesday and Friday, 0600 to 2200 Tuesday and Thursday, and 0800 to 1200 hours Saturday. The total available terminal hours is a constraint, since there are 64 PA students in any given semester, plus 30 PCNP students who attend PA clinical medicine lectures.

2. POI Hours. For planning purposes, hours are considered to be POI hours planned for a particular subject. POI hours may not necessarily equate to hours actually spent at the terminal by a given student. PLATO material at the lesson or lesson sequence level is self-paced and variations in individual students can be expected.

3. Classroom (C/L)/Complementary Technical Training (CTT) Hours. Since computer assisted instruction is designed to teach for mastery of the material, a PLATO IV lesson designed to meet a particular POI objective will replace both the associated classroom hours and CTT hours. In computing hours in the present curriculum to be replaced by PLATO material, both C/L and CTT hours are considered.

B. Hours Required for POMC Material.

1. The present PA curriculum has been examined to identify those hours in which the subject matter is essentially the same as POMC content and can therefore be replaced by the comparable POMC material. A detailed breakdown of hours by POI objective by semester is included in Attachment 1. A summary is provided in paragraph 3 below.

2. As anticipated, some material included in the POMC does not have direct comparability with hours in the present curriculum. This material is limited to "simulated patient encounters" which is expected to require 24 student contact hours. These hours are considered to be an essential part of the POMC for review and reinforcement.

3. Summary of Hours

Replacement Hours:

	C/L	CTT	Sub-Total	Total
1st trimester	16.5	7.5	24	
2nd trimester	20.0	5.0	25	
3rd trimester	52.0	20.0	72	
Sub-total	88.5	32.5	121	121
Additional Hours:				
Simulations			24	
Sub-total				24
Grand total:				145

4. In the original research proposal an arbitrary estimation of 200 course hours was designated for PLATO IV programs. The reduction in these hours to 145 represents the integration of an effective circumscribed curriculum into the present course with the least

disruption of continuity. The expansion of the PLATO hours to reach a closer approximation of the original estimation of hours would only serve to dilute the effectiveness of the PLATO project, complicate the evaluation procedures and increase the problems of integration into the present course.

C. Plan for Implementation

1. A sample of 16 Physician Assistant students will be selected from the freshman class starting in June 1975 to serve as a pilot group. Sampling techniques developed by AFHRL will be used to select the 16 students. A second sample of 16 students may be selected from the class starting in Oct 1975 if that is considered desirable on the basis of evaluation plans and experience with the initial group.

2. Students in the sample will complete PLATO materials in lieu of the corresponding work in the current curriculum. They will attend all of the scheduled lectures, except those that have been replaced by PLATO lessons. In addition to criteria listed in IV-C above, considerable concessions have been made in the selection of material to be included in the POMC so that discrete lecture hours of the current curriculum are identifiable. At the time such lectures are given, students would leave the classroom and report to the PLATO lab for computer based instruction. Overall, the same criterion objectives will be met by all students, but the temporal sequencing of material in the problem oriented medical curriculum will not necessarily parallel that of the current curriculum.

3. The additional hours required for the simulated patient encounters included in the POMC will be supplemental hours to be done at the student's conveniences. This will provide review and reinforcement of material covered in Phase I.

4. Since students in the sample group will not necessarily be working on the same subject matter at the same time as the rest of the class, some modification of the normal end of block evaluation procedures will be required. POMC students would take the normal end of block tests, but questions covering coursework taught in the POMC would not be counted in their test score. The PLATO IV staff will assume responsibility for determining student proficiency in the POMC subject areas on a semester basis to determine whether or not the student is competent to proceed, needs remediation, etc. The PLATO staff will also assume responsibility for needed remediation in those areas.

VI. Tasks Remaining to be Done

A. A detailed schedule must be developed for the present curriculum that identifies specific subjects for specific lecture hours, and also identifies hours during which POMC material is to be taken by the sample group.

B. Waivers from course documentation requirements and testing standards must be requested from Hq ATC.

C. Any questions involving accreditation from the University of Nebraska for the sample group must be resolved.

1 Atch
Breakdown of Replacement Hours
by POI Objective

1st Sem - Replacements
POI 3ALR91730 (Vol 1)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
VI	6a	Identify the clinical topography of the thorax	(4/2)	Anatomy (The Trunk)	4/2
VIII	11b	Analyze the principles of the heterophile test	1.5/.5	Serology	1.5/.5
	11c	Translate the principles of the antistreptolysin-O	1/.5	Serology	1/.5
	11e	Compare the principles and procedures of the febrile agglutination tests	1/.5	Febrile Agglutination	1/.5
IX	4	List the steps in the Gram Stain, Acid Fast Stain, and KOH preparation, and list the purposes for performing microbiological stains on clinical specimens	2.5 (2/.5)	Staining procedures	2/.5
	6a	List the proper methods of specimen collection, the pitfalls in the handling of clinical specimens, and relate the collection and handling of specimens to bacterial and viral infections	1	Specimen Collection	1
	8	Antibiotic susceptability test. Compare two methods of testing the susceptability of bacteria to microbial agents and interpret results of such tests.	2/.5	Antibiotics	2/.5

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
IX cont'd	9d	Identify the acid fast organisms and their clinically significant pathogenicity	4 (2/2)	Clinical Correlation of Common Pathogens (Acid Fast Organisms)	2/2
X	6a	Select the basic assumptions of the theory of kinetic molecular gases	3 (2/1)	The Gas Laws	2/1
	6b	Solve problems involving changes in the pressure, temperature, volume and number of moles of gases.			
				TOTAL HOURS:	16.5/7.5

2nd Sem - Replacements
POI 3ALR91730 (Vol 2)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XII	6b	Describe the mechanisms for maintenance of fluid and acid-base balance in the body fluid compartments and determine the use of laboratory test results in classifying abnormalities.	8 (6/2)	Fluids and Electrolytes (Acid-base balance and lab tests. O_2 and CO_2 transport. Resp acidosis & alkadosis	6/2
XIII	3a	Describe the anatomy and explain the physiology of the respiratory system.	12 (9/3)	The Respiratory System	9/3
XIV	6b	Identify and determine treatment of common diseases of the nose.	6 (5/1)	Diseases of Ear, Nose and Throat - (Nose)	3
	6c	Identify and determine treatment of common diseases of the oral cavity and the larynx.	5	Diseases of Ear, Nose and Throat - (Throat)	2
				TOTAL HOURS:	20/5

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Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XVIII	1a	Identify the atmospheric condition that can affect the human body in flight.	3	Flight problems	3
XIX	2a -n		13 (8/5)	Interpretation of Chest X-ray	8/5
	2a	Name the radiographic densities produced by roentgen beam.	(1/1)		
	2b	Name the anatomic structures described on a routine posterior/ anterior and lateral chest x-ray.	(.5/1)		
	2c	Determine the systematic method for examining the roentgenograph.	(.5/1)		
	2d	Name at least six positions and/ or techniques for evaluating the chest by radiography.	(.5/1)		
	2e	Interpret the silhouette sign and describe the anatomic location of chest lesions utilizing the silhouette sign.	(.6/1)		
	2f	Name primary and secondary signs of atelectasis.	(.4)		
	2g	Define the air bronchogram.	(.5)		

3rd Semester (cont'd)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XIX cont'd	2h	Name criteria for differentiating alveolar and interstitial lung diseases by x-ray.	(.5)		
	2i	Interpret roentgenographic features to determine the nature of the solitary lesion (benign or malignant) of the lung.	1		
	2j	Identify calcification within the lung.	.5		
	2k	Identify radiographic abnormalities associated with diseases of the pleura, extrapleural space, and diaphragm.	1		
	2l	Name the three arbitrary compartments of the mediastinum and structures found in each compartment.	.4		
	2m	Describe the chest x-ray and lung scan signs of pulmonary emboli.	.3		
	2n	Delineate the major signs of chest trauma.	.3		
XX	4a	Describe the actions, effects and uses of the antihistamine drugs.	3	Histamines and Antihistamines	2/1
	22a	Explain the actions, effects and uses of drugs used to combat infection.	9/5	Chemotheraphy	9/5

3rd Sem (cont'd)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XXI	9	Allergy	4	Allergy (Immun. Mech)	4
	13b	Describe the syndrome and treatment of coryza, pharyngitis, bronchitis, and pneumonia, and name the characteristics of bacterial and non-bacterial pneumonia.	3/1	Infectious Diseases	3/1
	13d	Discuss mononucleosis	1	Infectious Diseases (Mono)	1
	21a -p	Pulmonary Diseases	28 (20/8)	Pulmonary Diseases	20/8
	21a	Describe special procedures applicable to etiologic diagnosis and essentials of data base.	1		
	21b	Define lung function and normal pulmonary anatomy, and describe the physiology and pathophysiology of the respiratory system.	2/1		
	21c	Name reasons for performing pulmonary function testing and describe routine tests of pulmonary function, name four mechanisms of hypoxemia, and how to detect and differentiate these mechanisms.	3/1		
	21d	Name and define categories of chronic obstructive lung disease and describe pathophysiology of cystic fibrosis.	3/2		

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3rd Sem (cont'd)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XXI (cont'd)	21e	Define respiratory failure and describe the physiologic effects, etiology, diagnostic tests, therapy, complications and prognosis.	1		
	21f	Define thromboembolism and infarction, and describe pathophysiology and treatment.	1		
	21g	Describe primary alveolar hypoventilation, alveolar proteinosis, and desquamative interstitial pneumonia.	.5		
	21h	Describe diseases associated with kyphoscoliosis and ankylosing apondylitis.	.5		
	21i	Describe Goodpasture's Syndrome and ideopathic pulmonary hemosiderosis.	.5/.5		
	21j	Describe lung abscess and diseases of pleura	.5/.5		
	21k	Describe the physical signs and symptoms of aerobic and anaerobic bacterial pneumonias, and mycotic diseases of the lungs.	2/1		
	21-l	List types of neoplasms, describe primary tumors of the lungs, and discuss the significance of the solitary nodule.	1/.5		

3rd Sem (cont'd)

Block	Paragraph	Objective	Present Hours	Subject	POMC Hours
XXI (cont'd)	21m	List clinical features of pulmonary fibrosis and describe the radiographic picture and pulmonary function abnormalities associated with diffuse interstitial fibrosis and the Hamman-Rich syndrome.	1/.5		
	21n	Describe inhalation diseases of the lungs due to organic and inorganic dusts, noxious gases, and other agents.	1/.5		
	21o	Describe epidemiology, causative organisms, immunology and treatment of tuberculosis.	1/.5		
	21p	Describe the pathogenesis and clinical aspects of sarcoidosis, Wegener's granulomatosis, and eosinophilic granuloma.	1		
XXI	23j	Describe common respiratory problems in childhood, their evaluation and management	2/1	Pediatrics (Respiratory dis. of childhood)	2/1
				TOTAL HOURS:	52/20

APPENDIX C

POMC Evaluation Plan

PROBLEM ORIENTED MEDICAL CURRICULUM

EVALUATION PLAN

(prepared by AFHRL/TT as a result of evaluation conference held 6-7 Mar 75 at Sheppard AFB)

BACKGROUND

Under the auspices of the Advanced Research Projects Agency (ARPA) and Air Training Command (ATC), a Problem-Oriented Medical Curriculum supported by PLATO IV technology is being introduced in the School of Health Care Sciences. PLATO can provide individualized instructional material presented through a computer controlled plasma panel. The essential notion behind the Problem Oriented Medical Curriculum (POMC) is that academic subject matter should not be introduced in isolated units, but rather in the context of clinical diagnosis of actual patient problems. In this fashion, it is anticipated that problem solving skills will be developed to a greater degree, that retention of information will be enhanced, and that student motivation will be increased. Details covering introduction of this innovation into the Physician's Assistant Course can be found in the POMC Implementation Plan, 10 Feb 75.

PROBLEM

The goal of this evaluation plan is to develop a set of procedures for assessing the effectiveness of the proposed POMC.

RATIONALE

The initial step in the process is to define a rationale which underlies and supports the entire evaluation. Proper evaluation is obviously a complex matter, for the concept of "effectiveness" is clearly multidimensional. However, two sets of questions seem to be generated almost immediately. The first group is primary and basically operational in nature; these questions are designed to create a rational

policy for or against full scale implementation of the innovation. Simply stated, this set of questions asks:

- can it be done?
- is it instructionally effective?
- what does it cost (to institute, to operate, to maintain)?
- is it reliable?

A secondary, or research-oriented group of questions is also of interest. These are directed at explaining the success or failure of the innovation in the particular environment studied. This set consists of asking

- how was it done?
- why was it effective?
- how could it be improved (in terms of costs lowered or effectiveness increased)?

These latter questions are not unimportant, but higher priority must be given to the first set since they were judged to be more relevant to the purposes of the sponsoring agencies (ARPA and ATC). To some extent the secondary questions will be addressed in the final report, especially with regard to describing the process involved in setting up the POMC, but the major emphasis of available resources is being placed on answering the first group of questions.

Another issue which was faced in planning the evaluation concerns the extent to which comparative measurement will be made, as distinguished from following purely descriptive procedures. This distinction is analogous to the difference between norms referenced and criterion referenced measurement. In the comparative approach, procedure A is compared with procedure B on various criteria of effectiveness, while

	STUDENTS					AUTHORS		PLATO IV	
	Instructional Effectiveness		Job Task Performance	Atti-tudes	Perform-ance	Atti-tudes	Personal Charact-eristics	Cost	Reliability Maintain-ability
	Knowledge	Skill							
COMPARATIVE	X	X	X						
DESCRIPTIVE	X			X	X	X	X	X	X

Figure 1

in the descriptive approach, effectiveness is measured with respect to meeting standards or specifications in some absolute sense. Each approach has its own peculiar advantages, but, where feasible, it was decided to use comparative measures as much as possible in order to contrast the POMC approach with traditional instruction.

Another conceptual consideration important for this rationale deals with focusing on which aspects of the situation should be studied. Although not exhaustive of the possibilities inherent in this situation, three major aspects were identified for intensive study--students, authors, and PLATO IV itself.

A final concern involves deciding which specific characteristics and variables need to be measured. Since student and author performance are crucial to judging effectiveness, these naturally are emphasized. But it was also viewed as important to measure attitudes and to sample opinions from the participants. In addition, concern with author background characteristics and their relation to performance was seen as both researchable and important for future implementation. With respect to the PLATO device, its various cost factors and overall reliability must be addressed.

The foregoing considerations gave rise to Fig. 1 which outlines the major studies to be completed as part of this evaluation. Two further constraints which influenced the choice of particular studies were (a) the necessity to work within the guidelines of the POMC Implementation Plan, and (b) the limited manpower resources of both the PLATO Development Branch and AFHRL.

SAMPLING CONSIDERATIONS

For those studies involving comparative evaluation of students, a POMC test group (numbering 16) will be selected from personnel entering

June 1975. These students will be presented specific problem oriented material on PLATO IV, rather than receiving the "equivalent" instructional material in the traditional classroom setting. These materials will be distributed throughout the entire three semesters of classwork at the School of Health Care Sciences (SHCS). The remaining 48 students from the June 1975 class will serve as a control group and will not be exposed to the problem oriented material related to Respiratory Disease on PLATO IV.

The POMC test group will be randomly selected from the PA students entering in June 1975. If the sample chosen by this method does not differ significantly from the control group on SAT composite scores, the sample will be accepted as representative. If there is an appreciable difference between the control and test group on SAT composite scores, a new selection of groups will be necessary since it has been shown that there is a high correlation between high composite SAT and success in the PA course. If a second selection process is necessary, the entire class will be rank ordered on SAT scores. An equal number of students will be randomly selected from the high and low strata. Sample size can be increased to 32 by following the same procedures for the next entering class, thus increasing the power of this design.

STUDENTS

1. Academic Knowledge (Study 1)

The purpose of this comparison is to determine whether there are differences between POMC students and students in the traditional curriculum with respect to academic knowledge of respiratory disease subject matter. If the POMC succeeds in teaching this material at least as well as currently, then academic quality will have been maintained.

Since slight differences in emphasis and content are found between the POMC and the traditional curriculum, academic test items from currently used block tests could be unfair to POMC students. Likewise, the POMC generated end-of-block test items could be biased against the traditional students. To resolve this difficulty, a test covering respiratory disease will be constructed consisting of items that are similar to those found on the American College of Medicine/Board Examination. These items will come from the Educational Testing Service (ETS) item banks. In the event that ETS cannot supply these items or more items are necessary, experts in respiratory disease from outside the SHCS (for example, University of Nebraska PA staff) will be asked to contribute test items. These procedures will insure content validity since these test items will tap knowledge that is considered important by independent experts in respiratory disease.

This initial item pool will be further refined by testing a group of Physician's Assistants just at the end of their second year of training. Item statistics will be computed on this sample, and items for the final form of the test will be chosen in accordance with statistical criteria so that only reliable and discriminating items of appropriate difficulty are included. In addition, this procedure will provide a normative sample against which scores of the test and control groups can be compared.

The final form of this test will be administered to test and control groups at the end of phase I of the course, thus delayed retention will be measured for both groups.

2. Problem Solving Skill (Study 2)

The skill to be assessed in this comparison is problem solving or diagnostic skill. By presenting several simulated patient encounters,

we can test the student's ability to integrate his knowledge toward successful diagnosis and treatment of a patient. These exercises will essentially be paper and pencil problem descriptions, but the student will be able to request information, prescribe treatments, and note effects. In a limited since he will be able to "interact" with the simulation. Scoring criteria would include correct use of available information (lab tests, patient history, physical examinations, special tests, etc), correct sequence of steps toward diagnosis, accuracy of diagnosis, appropriate indication of treatment, time to completion.

Two or three Simulated Patient Encounters will be presented to both groups at the end of the course. It is planned that these simulations will be available from ETS or drawn from simulations which are already in existence. It is felt that creation of simulations by the PLATO and PA staffs should be avoided to eliminate bias.

3. Student Attitude Questionnaire (Study 3)

The main objective of this study is to discover whether POMC students have positive (or negative) attitudes toward the curriculum and/or the PLATO system. To this end, a 26 item version of the Brown questionnaire, used by Florida State University in a recent study, has been selected. This instrument has demonstrated reliability with college students (r=.80), and includes many specific questions which will permit inferences about the various features of PLATO (e.g. perceived reliability of terminals, depersonalization, etc).

It is anticipated that the attitude questionnaire will be given in the first and twelfth month of the course in order to detect differences as experience with the POMC and PLATO increases. Analyses of the relationship between attitude and performance on the final academic test and simulations are planned.

4. Lesson and Block Tests (Study 4)

Here the evaluation will be descriptive and formative in contrast to the previous study which was comparative and summative. The goal is to show that POMC students are meeting learning objectives as they progress through the course. Number of lesson repeats, number and duration of special remediations, eliminations or washbacks will be reported.

AUTHORS

1. Performance (Study 5)

Author performance will be measured in three ways: (a) average quality of lessons produced (as judged by University of Illinois Personnel and student), (b) supervisory ratings of performance, and (c) peer ratings of performance. Performance dimensions to be rated will include programming ability (competence with Tutor language), efficiency in lesson design, creative use of instructional techniques, novel applications of PLATO, etc.

Questionnaire instruments will be designed by AFHRL for administration as soon as possible, so that time comparisons can be made to show the effect, if any, of experience.

2. Attitudes/Opinions (Study 6)

Attitudes of authors will be measured primarily by a questionnaire yet to be developed. Two purposes are paramount here--(a) to be able to describe specific strengths and weaknesses of the PLATO equipment, and (b) to investigate the relationship between attitude and performance. Dimensions to be sampled include: attitudes toward CAI in general, feelings about individualized instruction and the problem-oriented approach, human factors aspects of terminal design, problems in lesson design, etc.

Questionnaire data should be supplemented by interview data with interviews to be conducted by AFHRL. Also open ended opportunities will be included in the questionnaire format.

Two measurements of attitudes and performance will be made at different times. Cross-lagged correlation analysis may yield some insight into whether attitudes cause performance or vice versa.

3. Characteristics (Study 7)

An attempt will be made to relate author personal and background characteristics to performance on the project. To this end, data will be collected on such variables as level and type of education, age, rank, IQ, attitudes, volunteer/nonvolunteer status, interests, etc. The aim here is to predict what kinds of people make successful authors for possible selection purposes.

PLATO IV

1. Cost (Study 8)

Since the PLATO Development Branch is a cost center, aggregate operating and development cost figures can be readily obtained. Management analysis personnel will be contacted for consultation purposes. Capital investment figures should be available from ARPA. A projection of expansion costs under several scenarios should be a part of the final report.

2. Reliability (Study 9)

Logs will be maintained to show number of terminals in commission per day, percent of down-time per terminal, cause of failure. Time phased analyses can be made to detect trends.

SUMMARY

Figure 2 gives an overview and summary of the plan with responsible agencies and deadlines specified.

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EVALUATION

MILESTONES* AND RESPONSIBLE AGENCIES**

	Study Design	Measurement Instrument Development	Data Collection	Data Analysis
Students				
Study 1	C (HRL)	Apr 76 (ETS)	May 76 (MSDM)	Jul 76 (HRL)
2	Oct 75 (MSDM)	Apr 76 (ETS)	May 76 (MSDM)	Jul 76 (HRL)
3	Apr 75 (HRL)	C (MSDM)	Jul 75 (MSDM)	Jul 76 (HRL)
4	May 75 (MSDM)	Jun 75 (MSDM)	Jul 75 (MSDM)	Jul 76 (HRL)
Authors				
Study 5	May 75 (HRL)	Jun 75 (HRL)	Jul 75 (MSDM)	Aug 76 (HRL)
6	May 75 (HRL)	Jun 75 (HRL)	Jul 75 (MSDM/HRL)	Aug 76 (HRL)
7	May 75 (HRL)	Jun 75 (HRL)	Jul 75 (MSDM)	Aug 76 (HRL)
PLATO				
Study 8	Jun 75 (MSDM)	Jul 75 (MSDM)	Jul 75 (MSDM)	Sep 76 (MSDM/HRL)
9	Jun 75 (MSDM)	Jul 75 (MSDM)	Jul 75 (MSDM)	Sep 76 (MSDM/HRL)

HRL = Human Resources Laboratory, Technical Training Division
ETS = Educational Testing Service
MSDM - PLATO Development Branch

* date given is deadline, interpreted as Not Later Than
** indicated in parenthesis
C completed

Figure 2

APPENDIX D

Proposal for Phase II

9 December 1975

AN EVALUATION OF THE EDUCATIONAL AND COST EFFECTIVENESS OF THE PLATO SYSTEM

I. Introduction

The CERL proposal, "A Coordinated Evaluation of the Use of PLATO at Military Training Sites," dated 17 Nov 75, cites the basic question toward which research must be directed as: "Under what conditions can CBE make a cost effective contribution to the instructional needs of the services."

On the basis of the experience gained through current research effort into the development of a new problem oriented curriculum at the physician assistant level, using the PLATO IV system, the School of Health Care Sciences is in a unique position to assist in research of a subset of this question, specifically, "can applications for the PLATO IV system and related instructional programs be found within a military training environment which are instructionally effective and cost effective."

The Sheppard capability to pursue this question centers on the fact that a trained staff is already in place; physical facilities, including a PLATO classroom with necessary terminals, carrels, communications equipment, power and supply already exist; and the SHCS offers a wide variety of courses designed to provide training in numerous specialities at all skill levels using a wide range of instructional techniques and strategies. Therefore, the SHCS offers an ideal environment in which the continued exploration of the effectiveness of CBE can be evaluated.

II. Rationale

As noted previously, the examination of both the educational and cost effectiveness of the PLATO system in military training is a question that must be addressed. The current research effort is not designed to meet this need for a number of reasons; specifically, it primarily addresses the impact of a major curricular modification in a course that is unique in military medical training. Additionally, the highly specialized nature of the Physician Assistant course and its inherent time constraints prohibit the demonstration of either actual or potential time, or cost savings.

A preliminary survey of courses conducted within the Departments of Medicine, Dentistry, Nursing, Biomedical Sciences, and Health Care Administration revealed a number of existing courses which appear to be well suited to investigation of the cost and instructional effectiveness question cited earlier.

III. Proposed Research Design

The major issues of cost and instructional effectiveness can best be addressed by a series of individual, but well integrated studies. The key to the success of any research in this area is the selection of a course in which optimum potential for cost and instructional effectiveness is perceived. Additionally, it must be understood that the emphasis of any research undertaken at this time must focus on evaluation aspects rather than an extensive courseware development effort.

To insure identification of the optimum course, a number of tentative selection criteria are suggested below. Criteria were selected to minimize implementation impact, maximize data collection potential, and utilize existing resources. Proposed criteria include:

a. maximum class size

b. trained personnel requirement (TPR/for year)

c. course length

d. class entry schedule

e. instructional methods (lecture, self-pacing, etc)

f. PLATO staff backgrounds

g. hardware resources

h. homogenity and interest of traditional faculty

i. transferability to civilian community

Preliminary application of these criteria to the courses currently being taught at the SHCS resulted in ten potential candidate courses which were deserving of additional evaluation and consideration. These courses are:

Course	Dept	Length	TPR	Max Gp Size	Entry Schedule
Radiology Specialist	MSDM	14 wk	237	24	4
IDT	MSDM	9 wk	32+	14	13
Diet Therapy	MSDB	5½ wk	112	12	3
Med Lab Spec	MSDB	17 wk	373	32	3
Op Rm Spec	MSDM	8 wk	228	16	3

Course	Dept	Length	TPR	Max Gp Size	Entry Schedule
Med Admin Spec	MSDH	6 wk	232+	20	2
Med Mat. Spec	MSDH	6 wk	265	20	3
Med Rec. Mgmt	MSDH	5½ wk	90	15	9
Dent. Spec	MSDD	9 wk	255	15	3
Prev. Dent. Spec	MSDD	7½ wk	90	12	6

IV. Proposed Studies

Studies which can be accommodated under this proposal will provide CERL and the sponsor valuable data with which to address many of the questions put forth in the CERL proposal. Specific studies of interest to ATC, AFHRL, ARPA, CERL and SHCS can be designed to address the following topics:

a. CBE lesson effectiveness versus lectures

b. CBE lesson effectiveness versus other self-paced media

c. effectiveness of alternate instructional strategies in CBE lessons.

d. lesson optimization in relation to time savings

e. cost effectiveness determination

f. attitudinal data

(1) students

(2) CBE authors

(3) traditional instructors

In order to avoid the evaluation problems which impact the on-going research effort, every effort will be made to insure that comparable cost and effectiveness data can be collected from both the proposed PLATO application and the traditional (control) course.

V. Resources Required

Personnel - current authorizations less Physician

Equipment - all required equipment is currently in place

Time - 1 year

Cost - Approximately $90K (Communications & Computer Support)

AN ANALYSIS OF POMC COURSEWARE AT SHEPPARD AFB

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INTRODUCTION

This chapter critiques Sheppard's problem-oriented medical curriculum courseware. The problem with reviewing a group of lessons together is that it's difficult to talk in anything but averages and generalities. Without describing each lesson separately, it's hard to convey the variations in approach and quality in this potpourri of both the creative and the commonplace. The Sheppard project was partially staffed by some of the most intelligent, conscientious authors at any ARPA/PLATO site. These authors produced inventive lessons, adapting well to the unique capabilities and necessities involved in using a computer-based approach to education. Other authors clung to old habits, transferring a lecture-like technique to PLATO. Some authors had no teaching experience, but modeled their lessons after the sort of instruction they themselves had been exposed to as students. Some authors welcomed the challenge while others resisted the change. Attitudes and comments ranged from, "I was taught by lectures and struggled through, so why should other students feel entitled to something better?" to, "Lesson writing is a tremendously creative, personal process... it's like giving birth!"

What this chapter describes, then, is the middle ground, the level where most authors operated, where most lessons "worked". The point, after all, was not to "be creative", but to produce approximately 150 student contact hours of computerized instruction.

PROBLEM ORIENTATION

As was discussed in "Critical Analysis of the Initial Phase of the Sheppard AFB CBE Project: The Problem Oriented Medical Curriculum", Misselt, 1978, a single, official definition of problem-orientation was never really made. Consequently, there were as many opinions of the meaning of problem-orientation as there were authors. Sheppard courseware reflected this divergence of opinion. Sheppard lessons were usually one of three types:

1. content-oriented
2. scenario-oriented
3. case-oriented.

All four types dispense information, but with differing emphases or focal points. In the first case, information is presented in a straightforward, almost lecture-like fashion. The emphasis is on lesson content only. These lesson authors felt the curriculum would (and should) be problem-oriented as a result of other kinds of lessons. These authors did not consider their content-oriented lessons part of the problem-oriented approach.

Authors using a "scenario" approach often introduced the lesson with a clinical depiction or situation. For example, one lesson opens with the following scene:

> "You're walking on the surgical ward and as you pass a room you hear a yell and a noise like a person falling on the floor. You rush in and there on the floor is a patient (45-50 year old male) not breathing, no heartbeat, no blood pressure present. You immediately begin CPR

(cardiopulmonary resuscitation) and call for help, but in spite of all the effort to resuscitate the patient he is pronounced dead. As you get up you notice a bedpan on the bed. WHAT HAPPENED? " *

Throughout the remainder of the lesson, the author used the opening setting as a springboard to introduce relevant information, frequently refering back to the clinical scene. However, the student is not expected to diagnose or "solve" the case.

Finally, authors sometimes used a case-oriented approach. The third trimester was to be almost totally comprised of simulated patient encounters in which the student was expected to diagnose and treat the condition. In addition, some lessons centered on less advanced simulations in which, rather than diagnosing and treating the case, the student had only to assess the case in some other way. For example, in one lesson the student is presented with an imaginary dialogue between a patient and doctor. The student's task is to determine whether the information the patient gives does or does not contribute to making a diagnosis. If the patient information is indeed important, the lesson branches to a brief discussion of the implications and importance of that piece of information. In a lesson on how to take a complete patient history, the student again sees a patient/doctor dialogue, and must decide whether the patient information is subjective or objective.

*An aside for those who are curious about the fate of our patient. Straining to use the bedpan had caused massive pulmonary emboli--a common concern with postoperative patients.

LESSON DEVELOPMENT

Student Population

Sheppard Physician Assistant students are a homogeneous group of highly motivated, hardworking people. All PA students are noncommissioned officers with 3-6 years of previous medical experience. They must also have completed a Medical Service Fundamentals course and training at a technical school. Thus, PA students are older than most military students, and serious about medicine as a career both in and out of the military. For this reason, they are generally self-motivated and, as one officer stated, "...study as long and hard as MDs."

Cognitive Levels

The Specialty Training Standards (STS 917x0 for AFSCs 91730/70, 23 February 1972) for the Physician Assistant course prescribe student objectives at 3 different levels:

1. task performance
2. task knowledge
3. subject knowledge.

The following section is taken directly from the STS "qualitative requirements" for the Physician Assistant Course. It lists the general cognitive levels and performance skills specified in the STS. The remainder of the STS expands on all areas of the course, enumerating which of these skills apply to what areas. Since the vast majority of the Sheppard/PLATO material was aimed at content rather than performance, only the objectives for task and subject knowledge have been included here.

Task Knowledge

a. Can name parts, tools, and simple facts about the task. (NOMENCLATURE)
b. Can determine step by step procedures for doing the task. (PROCEDURES)
c. Can explain why and when the task must be done and why each step is needed. (OPERATING PRINCIPLES)
d. Can predict, identify, and resolve problems about the task. (COMPLETE THEORY)

Subject Knowledge

A. Can identify basic facts and terms about the subject. (FACTS)
B. Can explain relationship of basic facts and state general principles about the subject. (PRINCIPLES)
C. Can analyze facts and principles and draw conclusions about the subject (ANALYSIS)
D. Can evaluate conditions and make proper decisions about the subject. (EVALUATION)

Sheppard lessons generally emphasized objectives aimed at nomenclature, facts, principles, and procedures. The analytic, evaluative, and problem solving levels were mainly concentrated in the simulated patient encounters. Though a small number of lessons required the student to either apply principles to new situations or synthesize information and form a conclusion, most lessons expected only that the student be able to list or restate information, name or identify structural components, list causes/effects, etc. For example

--State 4 factors that affect the diffusion of gases.
--Name 3 methods of sputum collection.
--List the agents/factors responsible for upper airway diseases/disorders.

--Identify and name the bones that make up the thoracic cage.
--Name the 4 lung volumes and match each name to it's respective volume.

are objectives taken from POMC lessons which typify the sorts of tasks and levels of understanding required of students. Certainly some aspects of clinical science involve rote memorization, and often all that needs to be tested is whether the student has actually committed them to memory. However, the problem solving skills alluded to in both the STS and course definitions of the POMC were only intermittently reflected in actual behavioral objectives or stressed in the lessons themselves. One possible cause was that objectives were frequently written after the lesson itself was written. Often if it was pointed out that the objectives and lesson content were at variance, the author would rewrite the objectives. Many times authors seemed not to have a clear idea either of what they wanted the student to be able to do by the end of the lesson or of what actual on-the-job skills the student needed. This may have stemmed in part from the fact that few authors did any sort of task analysis before writing either the objectives or the lesson itself. This was particularly true of authors who lacked teaching experience.

Development Procedures

All authors had subject matter expertise in some area and wrote lessons concentrated in their field. Some authors, however, also ended up writing lessons in areas they knew little or nothing about. This took up valuable time while they had to research lesson material. Also, as was pointed out in Sheppard's phase one report (Steinkerchner, Deignan, Waters & DeLeo), lack of subject matter expertise hampers a

programmer's ability to make "intelligent choices" about display, feedback, etc.

All curriculum materials were on PLATO. There was no media mixture. When MTC reviewers pointed out that some of the material was not well suited for computerization and could be more economically and effectively presented using another medium, authors insisted that all material had to be on line. For example, the laboratory testing procedures lessons were presented almost in the form of an on-line handout. Laboratory procedures were detailed in a step-by-step fashion. Then the student was often asked something like, "What is the first step in doing a gram stain" or some technical or procedural point. Some parts of these lessons did, however, include the underlying reasons for using various techniques, chemicals, etc. Thus the lessons were a mixture of both theory and practice, with rationale interlacing pages (sometimes as many as 3 full frames at a time) of step-by-step procedure. When asked whether as a Physician Assistant the student would ever have to perform these tests, the author admitted s/he would not. When the MTC reviewer pointed out that it might then be more effective to print procedures on a hard-copy hand out (since they were so textual) the author said all material had to be on-line regardless of whether it belonged there. The question of whether some material could really be taught best on-line never seemed to be part of the lesson development process.

As was briefly discussed in the previous section, the chronological order in which authors wrote their lessons varied tremendously. Toward the beginning of the POMC project an MTC member provided the Sheppard staff with a copy of Chanute's lesson development and documentation plan for possible adaptation to the Sheppard project. The Sheppard staff initially agreed that such an "official" policy would

be a good idea, and decided to institute a variation of Chanute's plan. After awhile, however, it became obvious that no standardized development procedures were actually being followed. Objectives were not being written, off-line preplanning was sporadic, etc. After this was pointed out, a period of about two months followed in which authors conscientiously wrote behavioral objectives before beginning programming their lessons. For some authors these objectives represented the only preplanning they did. Other authors wrote outlines or portions of lessons before coding. Finally, authors fell into the habit of writing objectives and criterion tests after the lesson was coded. In this way objectives were tailored to fit the completed lesson. The lack of objectives or preplanning in at least one instance produced a lengthy, rambling lesson which the author "wrote" directly on-line. Since this was his first attempt at lesson writing, he had not yet developed the repertoire of design skills necessary to extemporaneously write a lesson. However, he regarded lesson writing as a creative process that was only stifled by flowcharting, outlining, etc. As a result his first lesson took nearly a year to write and polish, and seemed at many points to be disconnected, with sections which followed consecutively but did not build on each other. The author's belief that lesson writing is a creative process is a sound one, and experienced authors are certainly able to write a fair amount of material on-line. However, just as one would not expect a jazz artist to ad lib a piece of music without having a solid musical foundation of discipline and knowledge, one could not reasonably expect that a "novice" author could ad lib a lesson without a solid instructional foundation of design and media experience.

LESSON DESIGN

Due to the range of knowledge and skill required of a physician assistant, Sheppard's POMC curriculum covers a wide gamut of subjects pivoting mainly around anatomy, bacteriology, chemistry and physiology, all specific to the respiratory system. The finished lessons fall into 3 general categories--those whose purpose is to present information, teach procedures or present clinical simulations. In addition, lessons can be further catalogued in terms of the approaches authors used in fulfilling the preceding purposes. Sheppard lessons employed 4 main instructional formats:

a. lecture/question
b. drills
c. tutorials
d. simulations.

Lecture/Question

The lecture format is the most commonly used approach in which content is stressed over tasks or problem-solving. The lesson usually unfolds in a linear fashion, with little divergence from the main path. The student is allowed to go forward and backward, and sometimes is able to branch off into a special help section. Lesson material is typically dispensed in a lecture/question order in which a number of frames ("pages") of text are first presented followed by a question or questions covering what the student has just read.

Drills

A few lessons use a drill approach in which the main

emphasis is on giving the student practice at using terminology, interpreting graphs, identifying various structural components (i.e. "touch the sternum in this drawing"), labeling data (is this information subjective or objective?), etc. Some lessons use a true drill approach (in which the student answers a number of items per concept), while other lessons use a modified drill approach (in which the student answers only 1 item per concept). In at least one case, namely the Anatomical Reference Terminology lesson, the material was either taught or gleaned in some other way, and the lesson was basically a review. In most other cases, however, the subject matter is briefly presented at the beginning of the lesson, after which the student is drilled on what s/he has just read. For example, in the lesson "Anatomy of the Thoracic Cage" the lesson first locates and labels various parts of the thoracic cage. Then the student is given a number of drawings of the thoracic cage on which s/he must point out which structures are which.

Tutorials

Another approach is the tutorial in which the student is "walked" through some procedure step by step. This approach is sometimes used as a form of help after the student has already answered a question incorrectly. It's also used in other cases such as the lesson on spirometry in which the student is led through a detailed explanation of lung volumes and capacities as demonstrated on a simulated spirograph. In other lessons, the student is guided through proper procedures for taking a complete patient history, doing specific laboratory tests, etc.

Simulations

The most obvious use of simulations in the Sheppard curriculum is the simulated patient encounters in which the student must collect a patient history, gather physical examination and laboratory data, then diagnose and treat the condition. No new subject matter is presented, the emphasis being only on having the student "solve" the case. Since the project ended before the third trimester for which the clinical simulations were scheduled, few students ever saw the simulations and the lessons were not in polished form at the end of the project.

A few other Sheppard lessons, particularly the lessons on gas laws, incorporated a different sort of simulation. Some of these lessons tried to demonstrate various experiments to illustrate cause and effect relationships. For example, one lesson simulates the effect on a manometer of increases and decreases in air pressure.

INSTRUCTIONAL APPROACHES

The following sections discuss various instructional approaches employed by Sheppard authors. Lessons are described in terms of the three main areas of testing, interaction, and style.

Testing

All the POMC lessons have end-of-lesson tests. There is generally one item per concept or student objective. Test items are almost always multiple choice, and, like the practice items in the lessons themselves, mainly test recall. Because of the small number of items, test reliability (and hence validity) is often low. It is our understanding that these tests were intended to be norm-referenced rather than criterion referenced in nature. Our analyses of the item response data preserved on the PLATO system have verified that many of the items have difficulty and discrimination indices which fall outside the ranges usually recommended for norm-referenced tests. Such items detract from the usefulness of the tests and should probably have been modified or eliminated in the test development process. Because of the extremely small sample (n=16) who were exposed to the PLATO instruction, however, the tests were never empirically validated. Hence, the only data that were ever collected for these tests were generated in actual operational use of the lessons. Given the hurried and limited nature of the test development, it is not surprising that so many of the items appear to be of little value.

Most authors did not believe that there was any need or place for mastery learning in the POMC. While some authors thought the criterion test should be discriminating, others thought that PLATO lessons could only measure short-term

retention, so there was no need or reason to measure mastery. This attitude may well have been a contributing factor to the 1:1 ratio of questions to objectives found in most of the criterion tests.

Interaction

Over the course of the Sheppard POMC project, the amount of student interaction (in the form of questions) increased markedly. Even lecture-type lessons became more interspersed with questions. However, the majority of questions were restricted to virtual verbatim, copy-frame type questions in which the student had only to reiterate some bit of terminology, list information or repeat data usually presented from one to three frames * before the question itself. In one lesson, for example, this definition is given for upper airway diseases:

"UPPER AIRWAY DISEASES

is the collective term given to diseases and disorders resulting from structural alterations or dysfunctions of the:

1.nose
2.paranasal sinuses
3.pharynx
4.larynx."

*A frame is any screen display only initiated by student input.

Two frames later, the student is asked:

"Upper Airway Diseases have been defined as disorders or dysfunctions of the:

(Please list the terms one-at-a-time.)"

1.

2.

3.

4.

In another lesson on pulmonary emboli, one frame states:

"In experiments, 75% of the pulmonary vascular bed may be gradually obstructed before pulmonary hypertension develops."

On the page immediately following, the student is asked:

"What % of vascular bed may be obstructed before hypertension occurs?"

Though most lesson questions (and criterion test items) are of a verbatim recall type, a small number of the introductory basic science lessons present the student with challenging word problem type questions. In a lesson on gas laws for instance, the student must apply Boyle's Law to solve at least 4 randomly chosen word problems of the following sort:

"An 11 liter container of gas is initially at a pressure of 14 atm. What will the pressure be if the volume is changed to 19 liters at constant temperature?"

Feedback and help. In the majority of lessons, feedback for incorrect student responses consists of a general hint. If the student misses the question a second time s/he is then told the correct answer and told to type in the correct response. The general help may be one of a number of sorts. One type is the form cue in which, rather than giving a cognitive clue, the hint consists of the starting letter, number of words in the response, etc. For example, in one lesson the student must answer the following question:

"If a nasal smear shows a large number of neutrophiles and eosinophils your patient most probably has an ___ with a superimposed ___."

If the student gives an incorrect response for the first blank, the feedback s/he gets is:

"Two words"

If the student answers incorrectly again, the next hint is:

"Initials 'a-r'"

Finally, after the 3 r d try the student is told:

"Answer - allergic rhinitis"

More often the feedback gives a content cue as in the following example. The student is given the question:

"In which state of matter are the molecules moving MOST rapidly?"

If the student answers incorrectly, the computer's response is:

"Molecular motion in solids and liquids is limited by the close contact of neighboring molecules."

A small number of lessons include questions with no help or feedback whatsoever. An incorrect response generally elicits only a noncommittal "Try again", "Press -BACK- for help" or a simple "no". The question must be answered before the student is allowed to continue, but s/he is left more or less to her/his own devices in divining the answer. While this is not the norm, it happens with enough frequency to deserve comment.

While many lessons offer the student "help" at a question, the help usually consists of having the student press a key which sends her/him back to reread some text s/he has already been through. This seems to be primarily a function of what cognitive level the question is aimed at. Questions aimed strictly at a recall level require little or no explanation (these are also the sorts of questions which have form cues for feedback). Questions that delve into higher cognitive levels, however, in which the student must apply rather than recite information, necessitate more sophisticated feedback and help. For instance, if the student has difficulty making a diagnosis in the clinical simulations, s/he is routed to a socratic sort of tutorial in which the student is led through the pertinent history and physical examination data to a diagnosis.

Style

Format. POMC lessons generally utilize one of three similar formats. The basic structure is a linear presentation in which all students take the same straight-lined path through the lesson. These lessons sometimes include a "roadmap" or "index" which maps out the route the student will take, but neither allows the student to choose her/his own path. A second structure, a variation on the linear format, is a design in which the student ping-pongs back and forth between sections of the lesson and a choice-index from which the student chooses the section s/he wants to study, but must take all sections in the order in which they appear in the index. If s/he deviates from that itinerary, s/he's told, "Since this is the first time you've been through this lesson, and since you have not completed section x, you may not yet go to section y." An advantage to this approach is that the student may, however, choose to review any parts of the lesson s/he has already seen. A third approach is a completely autonomous situation in which the student sees an index from which s/he can choose any section in the lesson in any order s/he wishes.

Graphics. The graphics in POMC lessons also generally fall into three main categories. The first type is often an animation (as opposed to a static illustration) which either demonstrates or depicts whatever concept is being discussed. One lesson, for instance, has an animation of a manometer which simulates the effect of changes in pressure. In another lesson the author plots various spirometrically determined respiratory pressures on a graph depicting the relative volume of each pressure. Graphics of this sort enhance or in some way broaden the student's understanding of a situation or concept either by simulating it or depicting it from a different perspective.

The second category consists of static "pictures" which mainly serve to illustrate the text. While some of these drawings are interesting or even entertaining, they don't generally add to the student's understanding or bank of knowledge (except in the sense that they "show" the student what a thing looks like). An example is a laboratory procedure lesson which includes a drawing of a laboratory slide with a drop of liquid. While the drawing is of some interest it probably adds very little to what the student already knows. This is not necessarily a criticism. A textual lesson with drawings is more interesting than one without, just as a book with pictures is more interesting than one without. However, removing the graphics would probably do little harm in terms of the student's grasp of the subject.

Another category is the medical illustration. Sheppard had an extremely talented medical artist on staff who created beautiful anatomical drawings. These drawings made an important contribution to the quality of a number of anatomy lessons.

The final type of POMC graphic is the "cartoon" type which can be best characterized as a non-realistic or imaginary illustration which students generally regard as "cute". An example is an imaginary flower-like drawing named Al Allergen in an allergy lesson which waves a petal "hello" at the student. Another instance from the same allergy series is a set of three figures used in a game in which the student must tell whether certain foods produce allergies or not. One figure is a running man, another is a sleeping man, and the third is a smiley-faced sun. While these sorts of drawings can make a frame interesting, if carried to an extreme, they can also annoy the student. POMC students commonly referred to one series of such lessons as "Sesame Street", and felt they were a bit juvenile.